

RD & W 1991

Geologists' Association

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Geologists' Association
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ON GEOLOGICAL SURVEYS.

BY HYDE CLARKE, D.C.L., ETC.
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At the outset of an institution of this nature it is desirable, with a view to its successful progress, that it should hold out advantages to the individual members, and the promise of public good. The organisation we have formed as the Geologists' Association will afford to each student of the science great and invaluable assistance: for by instituting a co-operation among working geologists, each will be directed and aided in his pursuits, and many new followers of the study be enlisted. It is not every one who has the time or the means disposable to enable him to make geology the aim and occupation of a life, as Buckland, Murchison, and Lyell have done. We cannot, many of us, undertake distant explorations, accumulate costly museums, or write and publish volumes; but there is a large body of men, and of women too, who can give themselves much satisfaction, and be the means of doing considerable good. The materials for geological collections are much more accessible than those of any other home museum. The mammalia are costly to preserve dead, as they are to maintain alive, and thus they can only afford a luxury for a princely Earl of Derby. Birds are attractive to the collector, but there is much trouble in the collection. The art of preserving the skins must be learned and practised: local specimens are few, but glass cases accumulate. Thus they do scarcely afford a homely pursuit, though some zealous weavers have fair collections. Insects afford to the same class, as to others of the working classes, and to wealthier students, a limited scope for their collection and preservation; and they come nearer to our collections in their facilities than perhaps any other, but we must claim the superiority for our own. An herbarium may be formed from the flora of one's neighbourhood; but inasmuch as the plants can be readily seen alive, and are familiar to those interested in the pursuit, the formation of an herbarium is not self-satisfying. Coins and antiquities are only found by chance, and must, under all ordinary circumstances, be purchased on the faith of a dealer, and with all the risk of spuriousness. Mr. Toulmin Smith, in his discourse, has referred to the blunders and frauds of dealers in fossils, but these are as nothing compared with what occurs to the purchasers of archaeological objects. Every house that is pulled down, and every foundation that is dug in the City, is attended by ingenious navvies and bricklayers' labourers, who are ready to sell to the incautious spectators and neighbours true and spurious coins, swords, and pottery; and many a man gives a sixpence for a Roman coin which neither in olden times nor now was ever worth half a

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farthing ; but he thinks it has been found under his own eyes. Some of these working class antiquaries have very large transactions with the dealers in antiquities and the fabricators of them. At this moment, notwithstanding a law suit between a dealer and the proprietor of the *Athenæum* the archæological world is divided as to the value of a find of what are called pilgrims' medals, or tokens.

Coin collecting seldom gets very far, but still, if indulged in at a considerable expense, the owner has always value for his money ; and there is one comfort, that the coins do not eat and drink, nor require much expense for their entertainment. It is, however, a vicarious pursuit, dependent on the good faith of others ; but in most parts of these islands a man may gather minerals or fossils for himself, and have the satisfaction of finding his own materials, and that is a great one. These he can, with a little time and trouble, dress up, and bring to a suitable condition for preservation and display ; and as the objects are durable, but little expense need be encountered by the humble collector. In many neighbourhoods a large number of minerals and fossils may be gathered, and then there is the resource of a ramble into another formation ; for, on account of the great complexity of our geological arrangements, we have in these islands abundant variety, far different from some of the great basins or plains of Russia and of India, where there are large districts with superficial diluvial or alluvial formations, without any intruded rock. Thus there is a great encouragement to the pursuit of geology here to what there is in many countries even near to us. Take, for instance, the low parts of Flanders, the like country in Holland, or the northern regions of Germany, where there is little for the humble student to explore on his own account. He may witness the gigantic operations of creative action, but he may learn them better at second hand from others than on the spot, as in his narrow sphere he wants the means of comparison, unless he be near the sea, when he may observe the likeness or identity of its shores and of the adjoining dry land ; but he has to witness the accumulated results of thousands of years, or the influence of phenomena long lost, with only a brick, as it were, to judge of a vast edifice, the means by which it was brought together, its form, its appliances, and the beauties of its construction.

By means of this Geologists' Association the home student will receive constant encouragement, for he can learn when he has remarkable specimens beyond the common means of reference, and by the increase of members, and the development of operations, he will have made accessible to him the whole of the regions of these islands, fertile in the records of every formation, from the primeval to the last depositions of sea or river silt. Thus he will not deem himself doomed to the possession of manifold copies or a few specimens, because he will know of working brethren in other districts, by exchange with whom, to make his fewer resources comparative wealth, and from the moment of collection to give him assurance that it depends on his own industry and energy alone to become the owner of as large a museum as his house will hold, and to be able to display to his neighbours the records of other districts, and afford practical materials for the study of the science to all who desire to extend their knowledge beyond books to the actual things themselves, which are the true coins and medals of this world's great history. This is a source of enjoyment which cannot fail to prove gratifying to any right-minded man, and the enjoyment of it will induce many to enrol themselves in this Association.

Our pursuits, too, have this moral advantage, that they are social, that they can be innocently engaged in by the young, and, what is of great importance, that our wives, daughters, and sisters may share with us the interest, the pleasure, and the honour. And you will remember how great a part women, quietly labouring, have had in the extension of our knowledge of the fossils of our islands. Mr. James De Carle Sowerby, whose eminence as a labourer in fossil conchology is known to you better, per-

haps, than his great acquirements in every branch of natural science, was kind enough to write me this memorandum as to our female geologists:—

“I know one lady now living who can be named independently as a geologist—Lady Murchison—who was at one time very zealous. Lady Lyell works at geology also to assist Sir Charles. Miss Benett, when living, stood very high. In Wiltshire she made a very extensive collection, and published a catalogue of them; she worked hard with her hammer. These ladies had long purses, and made good use of them. The late Marchioness of Hastings sought for fossils in the tertiary strata of Hampshire, and made some important discoveries of bones in the fresh water beds. Mrs. Cobbold, of Ipswich, collected the Cray fossils of Suffolk. Miss Beminster collected the fossils of Hordwell, both shells and saurians. In the same field was Mary Anning, a guide, who picked out very fine things for sale, and made herself fully acquainted with them. But these ladies have long passed away. There are, doubtless, others who are wearing their mantles, and will probably inherit their crowns, but I have not the pleasure to know them, having retired from their domains.—J. DE C. SOWERBY.”

The founders of this Association, mindful of these facts, have provided for the admission of women; and it is to be hoped that many beyond those elected this night will be hereafter enrolled in our list, and labour in this new sphere of usefulness.

Thus we may look forward with confidence to the constitution of a society which will count hundreds of members, dispersed throughout the country, and with greater means of doing good, generally and individually, in proportion to the increasing strength of the Institution: hence, pledged to us, our members will cease to look to the mere personal benefit of individual enjoyment, or the consideration of how many shillings' worth they get for a ten shilling subscription, but will feel that they have an interest in geological science for its own sake, and will feel an anxiety to promote it. Some whose circumstances will permit will give a more special attention to geological studies; and it is to be hoped that this Association will be the means of encouraging and rearing up many whom generations to come will acknowledge as true geologists. Some, whose means or pursuits allow them less choice, will devote themselves to promoting an interest in the science in their own district, and increasing the numbers of their fellow-workers. Some will take up the investigation of a local formation, or particular class of fossils, and earn for themselves distinction in our annals. Some may become famous by fortuitous discoveries, and their success encourage the general mass to greater efforts. Many a mining captain and many a working miner will, it is to be hoped, be enrolled among us, and be induced to take greater advantage of the rare opportunity of underground exploration. As the bent for other studies incline, so we shall have members who apply for our purposes a knowledge of chemistry and physiology, or devote themselves to microscopic examination. Thus in many ways the bounds of knowledge will be enlarged, and credit will be reflected on this Association.

There will, however, be the opportunity for combined exertion, in which the organisation of a body like this will be found particularly valuable. Except in Cornwall, there is no local Geological Society widely distributed in England, and there are few local societies, nor has the Wernerian Society compassed the whole of Scotland, or the Royal Irish Academy enlisted every working geologist in Ireland. To all the local societies this Association will give increased energy, while it will fill up the blanks between their territories. As the number of our members in each county increases, virtually a branch association will exist for each county; and with a further increase in each district, we shall have in each a local committee, known to each other, working together, and conversant with the features and resources of the neighbourhood. The chief obstacle to local geological societies is that few can afford to pay a two guinea subscription, and that nothing can be done with a half-guinea subscription; and thus their extension can never be general, and for the main work of the country they must be dependent on this Association, a fact of which it is to be hoped

we shall be mindful, and which is a great encouragement to our exertions. Naturalists' clubs may combine a few zealous workers, but they cannot afford funds for the publication of transactions, or communication of information.

It is a necessary consequence of our Institution that we shall have a local organisation as well as a general one : we shall have our local secretaries, and in some places our local committees ; and wherever a special investigation is to be carried on, we shall have the machinery to secure it. Whoever considers the formation of architectural and archæological societies throughout the country for the purpose of local observation, will see that we have likewise a wide scope for investigation. They have merely a few buildings to examine, and a few chance explorations, to gratify them, but we have the whole surface of the country open to us, and the fruitful contents of its strata. Thus our mission is greater, and we must endeavour to fulfil it.

It will be seen what assistance our local members will afford to the Geological Section of the British Association at its various places of meeting, and what opportunities they will have of carrying out any local enquiry. My object on the present evening is to show that our organisation permits us to carry out continuously and systematically that important end of geological labours—the study of the geology of our own country. The collector of fossils may gratify himself, but there his labours centre and end ; but he who adds one new fact to our knowledge of the geological formation of this country and its mineral resources renders a service to the common cause, and becomes a national benefactor, by the same title as he who grows two blades of grass where one grew before : he adds to our stock of knowledge, and thereby to our national wealth, for on the soil of this country are we greatly dependent for the growth of vegetable food, for the nurture of cattle, for the supply of water and water-power, for the provision of manures, for fuel, for the materials of building, for our metals, and the physical instruments of our greatness as a nation.

Let us briefly consider the effect of an individual discovery in this department of science. Take the anthracites, for instance ; their application for steam fuel has caused general researches to be made to ascertain our supplies of this fuel. The great discovery of the blackband ironstone, followed up by the explorer, has created in Scotland a vast seat of the iron manufacture, as the discovery of other stores of the metal have made Cleveland and Northamptonshire new seats of the same industry. The Torbane fuel, found useful for gas, has given a stimulus to the application of the like formation to industrial purposes. The adaptation of coprolites for agricultural purposes has made the working of these fossils a matter of importance. One word or one experiment has been the origin of branches of industry which employ their tens of thousands, upon minerals which once were lying waste and idle. In the cases here referred to districts unoccupied were made the seats of manufacture, or new resources were given for universal employment to populations ready to engage in them. Year by year the application of some mineral substance is discovered, and it comes into request. Thus the successful introduction of aluminium as an article of commerce is attracting attention to the sources of supply. The metal is almost universally diffused, but the best rocks or soils for metallurgic purposes have yet to be ascertained, and it is strange that as yet the aluminium workers of Europe are chiefly supplied from a local deposit of kryolite in Greenland, with one chief material for their operations.

That great national establishment of the Geological Survey is earnestly and perseveringly carrying on its labours, and mapping out these islands ; but it has to follow in the wake of the Topographical Survey, of which England is still incomplete, and of Scotland little is mapped out. This great work, when carried out, will make known to us the broad features of the geological formations of the country on the scale of the Ordnance Survey, of 1 inch to the mile ; and many details will be afforded by the

valuable reports on remarkable localities published in the annals of the Survey. This labour is not, however, at an end, and we can assist in it, but we can likewise assist the department as to those portions of the Survey already completed.

Let us take the case of a mine which has been sunk in Cornwall or South Wales since the Geological Map of the district had been published. This may afford us most important evidence as to the extent of strata or of a fault, their constituents, and the lodes that run through them. Even a fresh artesian well driven through the strata of the London basin is sure to give some new facts as to the thickness of the strata, and may illustrate some phenomenon of importance in relation to the geology of the locality. Wherever by mines, wells, or quarries, inlets are made to the inferior formations, we get at new and valuable facts—valuable still if the observations confirm our deductions from superficial indications, while the discovery of new fossils in a district has a material influence on its geological classification; for as we get a wider knowledge of the phenomena of the earth, so by the comparison of fossils we are better able to determine the relations between the members of a series. A formation found to be fossiliferous, which was supposed to be non-fossiliferous, or one found on further research to present fossils in different proportion from that assumed on hasty or partial examination, will obtain a different place in our maps and our records.

The Ordnance Survey, large as is the space its sheets occupy when joined together, is still too small for us when we come to examine local phenomena, when even in one field many soils are to be found, and where the substratum, which is of importance, may be found at various depths, of uncertain thickness, and of modified conditions. In the mountain regions of Wales and Scotland, which have not been subjected to minute explorations, many facts have to be gleaned by further enquiry in the process of time, and this we find to be the case even with regard to Cornwall, where the energy of men of science, and the ardour of the speculators, have caused constant surveys to be carried on; yet who will dare to say what the depths of Cornwall may still tell us, or what further resources may be made available from the heaps of attle refuse on the surface, and from the unexplored regions below.

A very striking proof of the manner in which geological facts are still gathered is afforded by an announcement at the last Manchester Geological Society, by Mr. E. W. Binney, the President, that within the foregoing fortnight he had been surprised to find *lias* in the neighbourhood of Carlisle, as geologists had lost sight of it between Cheshire and the Clyde. What he had seen probably extended over an area of 10 or 12 square miles, between the Maryport Railway and the Port Carlisle Railway, and was covered with a great deal of drift.

In order to promote these enquiries, and to obtain a better knowledge of the subject, this Association has the power to do much, and, fortunately, without imposing any burthen upon its pecuniary resources, for our subscription is small—enough to work out our plan, to provide rooms, offices, the expenses of correspondence, a library, a museum, and printing; still it may here be observed that our resources will prove larger than the mere amount of the subscriptions. Take, for instance, our museum; its chief value will not depend on our expenditure, but on contributions; so, too, our library of books and maps will be chiefly provided by donations and bequests, leaving us to find the room, the librarian, the binding, and current expenses. From time to time subscriptions will be raised among the wealthier members for special purposes; by and by we shall be able to fund our life subscriptions, and many years will not have elapsed before we have a considerable property, and are in a position to ensure the permanent existence of the institution. The object here proposed, so far from requiring funds from us, will bring us resources by inducing many public-

spirited men to become members of the Association. What we want to effect our purpose is organisation, and the free and willing labour of all our members.

The work must be one of time, slowly, steadily, and systematically carried on, because it is to be continuous and enduring in its fruits. It will require the services of a committee of the Association to set it in action, so that local committees, or sections of the members, may be arranged, and that the mode of working may be properly devised. Where we have only a few members in a district our endeavours must be limited to a few useful ends, but as our members increase we may undertake more minute enquiries. Each local section should have a secretary for this department of research, and perhaps a functionary in the nature of the *rapporteur* of the French academies, already known in our scientific circles as a reporter, who will have to draw up the yearly report of the labors of his colleagues.

The first duty of a section is an easy one, because the materials are in the libraries of the members, and that is to report on the state of the Geological Survey and records of their district. Their next task is to consider what deficiencies have to be supplied, and what objects of enquiry are open to them. In some districts they will find but little is needed, except to record new discoveries as they arise, but in most they will find that there is a wide field for minute delineation of the geological features of which the Ordnance maps only give the broad outlines, in some cases compressing the history of thousands of years, and the details of several strata within one coloured band. As greater strength is obtained, and the zeal of our members is encouraged, we shall obtain an extent of record not yet reached by any Government or in any country; for it is to be hoped the time will come when each superficial indication will be portrayed, and the township and parish maps of the Tithe Commutation Survey be made available for the registration of the geological features.

Thus, as has been shown by the careful collection of facts, we shall lay a sound basis for generalisation; we shall be able to authenticate or correct the rough outlines of our geological maps, and we shall give the man of science sound data on which to base the minutest enquiries. These maps will, like those of the Geological Survey, be accompanied by detailed reports of each district, giving its geological history and condition, and affording a basis for the aggregation of new facts. Thus we shall have in time authentic geological reports of each township and of each superficial formation.

The yearly reports of the sections and committees will furnish this Association with a mass of facts invaluable to geological science and of national importance, assisting and extending the Government Survey, and creating for this Association a solid reputation. Thus we shall become one of the recognised scientific bodies, and attain a degree of influence which will increase our means of doing good. It will be readily seen that for the promotion of such a great object we shall not only have sympathy but support, for all those interested in the practical applications of geology will, on public or private grounds, give us their co-operation; and the number of these are many, for they include persons interested in agriculture, mining, building materials, and in all the resources of our soil. As our labors will have a practical result, so will they receive practical support. There is not a landowner of any position but who knows the value of efforts which, by increasing knowledge, add to the value of the surface of his land, or make known resources in its substrata. Thus, too, that large and important class of scientific agriculturists, the new profession as it may be termed of farmers, have an interest in our success, for some distant discovery may be the means of providing fresh supplies of limes, sulphates, phosphates, and of the valuable mineral constituents of the cultivable soil. To the architect and engineer the investigation of stone, slate, marble, clay, cement,

lime, sand, and gravel, for purposes of construction, is a matter of importance. There are many manufacturers who require clay, flints, and china earths for ceramic wares; others sand for glass; and so almost throughout the circle of our industry. There is more particularly that vast branch of our national wealth which is dependent on our mining and metallurgy, and the persons connected with which have an intimate interest in encouraging our pursuits.

There is not a peer in the country who, though he may not have time to join in our work, will not feel that he must have some share in promoting it, and that his name must be inscribed in our list. There is hardly a man of science who will not be desirous to acknowledge that we are assisting his labours.

The heads of enquiry embraced in the yearly reports will vary according to the resources of the district, but they will embrace many features of great interest to theoretical and economical science. They will include:—

Additions to the surveys of maps, resulting from more minute classification consequent on local researches, or the application of general principles of geological science.

The announcement of new minerals, and more particularly economical substances which may become available.

The publication of the discoveries of fossils, thereby completing our paleontological records.

An account of all operations which have laid bare the surface, or penetrated beneath it, as mines, quarries, wells, pits, railway and road cuttings, tunnels, and landslips, and these will afford many matters of record.

Observations on the wells, springs, and subterranean strata of water.

Thermal observations on the surface and in mine shafts, and of superficial and subterranean waters.

Electro-magnetic observations on mineral lodes, an important branch of study, for which there have as yet been limited opportunities.

Records of earthquakes in particular districts, as those carried on by that zealous labourer in the field of science, Mr. Drummond, of Comrie, in Perthshire.

All phenomena affecting the surface should be recorded. Thus near the sea the abrasion of the shores, a matter of deep interest on our eastern coast, will be watched, and new cases of deposition examined. The like operations of rivers should be studied. Then there are evidences of recent abrasion on some of our mountains, which are worthy of notice. So, too, further evidence of boulders, glacier scratches, and ancient abrasions will be contributed, of water-worn surfaces, footsteps, and other local indications. The effect of agricultural operations on the surface should also be studied, as the removal of stagnant water by drainage, the interference with water courses, the mixture of soils and alteration of colour, the removal or extension of woods, all matters of interest in the investigation of the phenomena of the geological periods, and which will contribute to meteorology.

The result of special enquiries into the properties of the building-stones of the district, or of researches for metals, minerals, fuel, manures, raw materials or building substances found elsewhere in analogous formations.

As the system becomes organised, these reports will be published in the local journals, and contribute valuable information, while important facts selected therefrom, and included in our yearly report, and printed in our Transactions, will make the scientific world acquainted with the progress of our knowledge.

The CHAIRMAN confirmed Mr. Clarke's observations on the geological advantages of these islands, and referred to Yorkshire and the Isle of Wight. He dwelt on the practical advantages of geological knowledge, and alluded

to Dean Buckland's detection of a mason placing a defective stone on the top of a spire at Oxford.

Mr. MACKIE approved of the proposition of survey committees in connection with the Association, but feared that in some districts there would be a difficulty in obtaining men of adequate knowledge.

Mr. P. L. SIMMONDS spoke at some length on the value of economic geology, and the desirability of extending the operations of the Association to the colonies.

Mr. BOLLAERT was glad that some of his South American friends had joined, and hoped that many communications would be received from abroad. He promised papers for the Transactions.

Mr. G. H. BYERLEY spoke of the advantages of the proposed survey for engineering purposes, and referred to the mistakes, from ignorance, in the application of discharging or absorbent artesian wells.

Mr. F. W. BEAUMONT, in rising to propose a vote of thanks to Mr. Clarke for his paper, took the opportunity to remark that he knew several districts where the formation of this Association would be hailed with great satisfaction. He considered that it would be of very great use in the mining districts generally—South Wales, Cornwall, Staffordshire, Newcastle, Scotland, &c., where much valuable information might be gradually accumulated, with a view to which, and as a guide to the members generally, he took the liberty of suggesting that it would be highly desirable to have Mr. Clarke's paper printed and circulated. He (Mr. Beaumont) also deemed it desirable that all contributors should be recommended to make their communicated information a mere statement of dry facts, unadulterated with conjectures or opinions; which, however, might be advantageously appended.

Mr. HYDE CLARKE, in returning thanks, said he meant to persevere with the measure he had proposed.

* * The Committee desire it to be known, that the Association does not pledge itself to the opinions contained in the papers read at its several meetings; and they wish to direct attention to the scope of the original design, as contained in the following extract from its prospectus:—

“That there is much need of a common means of intercommunication among those who, while not devoting their lives to the pursuit, (of Geology,) yet take an active interest in its facts and teachings. The Geological Society is too far advanced in the strict course of scientific method and treatment, to be found available by the increasing numbers of those who desire modestly to seek mutual help as learners, but shrink from the assumption of ranking themselves among the illustrious Professors and Masters in the science.

“And that to meet this want, a number of Gentlemen have organized themselves into a *Geologists' Association*; having for its special purpose, the providing those means of intercommunication and mutual help.”

The Geologists' Association.

ON

THE RED CHALK OF ENGLAND.

BY

THE REV. THOS. WILTSHIRE, M.A. F.G.S.

PRESIDENT OF THE GEOLOGISTS' ASSOCIATION.

A PAPER READ AT

THE GENERAL MEETING,

4TH APRIL, 1859.

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LIST OF PLATES.

PLATE I.

Fig.

1. *Inoceramus Coquandianus*, from Speeton.
2. Fragment of *Inoceramus*, striated by glacial action, Muswell Hill.
3. *Nautilus simplex*, Hunstanton.
4. *Inoceramus Crispii*, Hunstanton.
5. *I. tenuis*, Hunstanton.

PLATE II.

1. *Spongia paradoxa*, Hunstanton.
2. *Siphonia pyriformis*, Hunstanton.
3. *Cardiaster suborbicularis*, Hunstanton.
4. *Ostrea frons*, Muswell Hill.
5. *O. vesicularis*, Hunstanton.
6. *Exogyra haliotoidea*, Hunstanton.
7. *Cytherella ovata*, Speeton.
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9. *Trochocyathus* (?) ———, Hunstanton.

PLATE III.

- 1, 1a. *Vermicularia elongata*. Upper and under surface of two different specimens, Speeton.
2. *Vermicularia umbonata*, Hunstanton.
3. *Serpula irregularis*, Hunstanton.
4. *S. antiquata*, Hunstanton.
5. *Bourgueticrinus rugosus*, Hunstanton.
6. *Diadema tumidum*, Hunstanton.
7. *Cidaris Gaultina* (?), Hunstanton.

PLATE IV.

1. *Terebratula biplicata*, 1a. mag. surface, Hunstanton.
2. *T. semiglobosa*, 2a. mag. surface, Speeton.
3. *Kingena lima*, 3a. mag. surface, Hunstanton.
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5. *Belemnites attenuatus*, Hunstanton.
6. *B. Listeri*, Speeton.
7. *B. ultimus*, Speeton.
8. *B. minimus*, Speeton.



ON THE RED CHALK OF ENGLAND.

A Paper read 4th April, by Rev. THOMAS WILTSHIRE, M.A.,
F.G.S., Etc., President.

PERSONS in general take as the type or representative of chalk the material which mechanics employ for tracing out rough lines and figures. It is a substance of a bright white colour, somewhat yielding to the touch, and capable of being very easily abraded or rubbed down.

But the geologist gives a much wider interpretation to the term, not limiting it by these few characteristics; and, accordingly, he includes under the same title many strata which would hardly be so grouped together by the uninitiated.

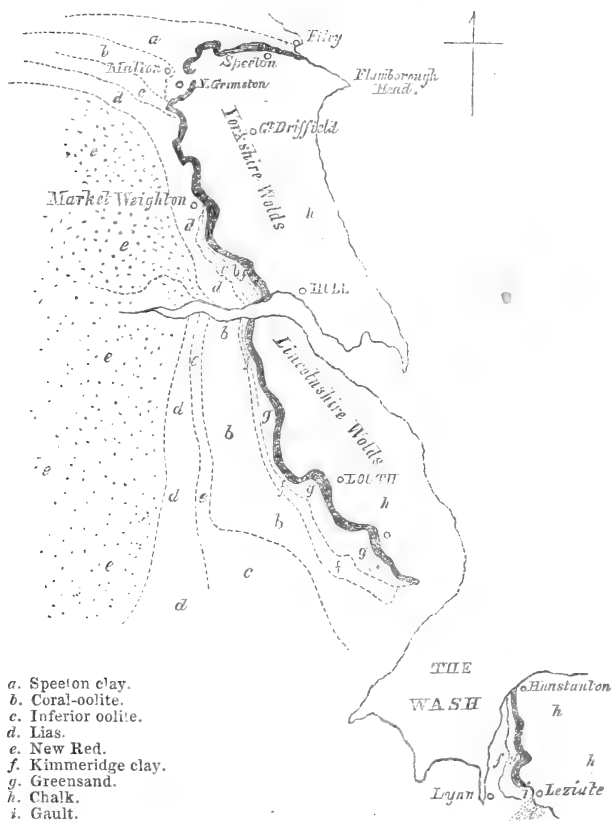
For instance, there is at the base of the upper portion of the cretaceous system a certain hard, often pebbly, and highly coloured band, which, notwithstanding its great departure from the popular type, is nevertheless styled in geological language the "Red Chalk." This stratum, the subject of the present paper, nowhere forms a mass of any great thickness or extent; perhaps if thirty feet be taken as its maximum of thickness, four feet as its minimum, and one hundred miles as its utmost extent in length, the truth will be arrived at. It may be said, also, to be peculiar to England, for the *Scaglia*, or Red Chalk of the Italians, has little in common with that of our country. The two differ widely in appearance, in situation, and in fossils.

The first view of the seam in the north is to be obtained about six miles north-west of Flamborough Head, in Yorkshire, near the village of Speeton, where its structure, dip, and general appearance can be remarkably well studied.

Speeton is a small village, a place of no great note in the business-world, yet of much fame amongst the lovers of geology, inasmuch as in its neighbourhood there are several interesting formations, to one of which—the Speeton clay—it gives a name.

In these days of rapid travelling, the village has the great convenience of a railway-station, from whence the cliffs below can be reached without the slightest difficulty.

As I wish to conduct the members of the Association to the Red Chalk *in situ*, let us suppose that, starting from some locality near the Hull and Scarborough Railway, we have taken tickets for Speeton



Lign. 1.—Map of Part of Yorkshire, Lincolnshire, and Norfolk, showing the Outcrop and Range of the Red Chalk.

station, and have in due time arrived at that latter place. On alighting from the train we must direct our steps to the houses in front, and then inquire the way to the sea-shore, above which we shall be standing at some considerable height—say four hundred feet. We shall be told to walk by the church, to turn to the right along a little lane, and then to look for an obscure path which passes across the fields. We shall soon afterwards, being on high ground, be able, by the light of nature, to find a way down to the sands below.

Whilst descending, let us survey the scene that lies before us. It is a grand one, rendered picturesque by the broken ground, the solitude, and the sounding of the waves. Right ahead, there is the open Bay of Filey; on the left hand, the town of Filey and its Brig; not a ship, as one might imagine, but a huge mass of rocks of the coralline oolite, jutting out to sea at right angles from the shore, like a pier formed by human hands, and crowned on the land-side by strangely cut pinnacles of pink and rugged drift. On the right hand there are the high and perpendicular white chalk cliffs of the Flamborough range. As we pass down we shall meet with a gulley or bed of a small stream, in all probability quite dry, by following the winding course of which we shall reach the shore. This gulley passes over an escarpment of diluvial matter (the whole place being in confusion through the effects of small landslips), and traverses the Red Chalk itself, the first trace of which will be rendered visible by means of rolled fragments, which the force of the stream has at different times detached.

It will be only here and there that we shall find the Red Chalk *in situ*, because sometimes vegetation, sometimes diluvium, sometimes fallen masses, entirely conceal its real position. However, there will be plenty of rounded pieces at the feet. Some of these had better be examined on the spot, in order that we may gain a clear perception of the appearance of the bed, should we meet with it again. These pieces are found to be hard and rough to the touch, and of a bright red tinge, though occasionally marked with streaks of white. Most likely on some of their sides a fossil or two will be seen peeping out; a blow from a hammer will divulge still more. So plentiful are the rolled fragments, that a few hours' work will satisfy the conscience, and fill the pockets of the traveller.

If I might be permitted to give advice to any member of our Association who should hereafter visit the place, it would be this—that it would be well for him to carry away moderate sized boulders entire, rather than to break them on the spot. The fossils will best be developed at leisure. The material is so hard, and the fossils so brittle (especially the belemnites and serpulæ), that imperfect specimens only will result from the quick and rough treatment of the hammer. The “find” will not produce any very great variety, only numbers; terebratulæ, serpulæ, and belemnites will be all that will be obtained.

Having now procured specimens, we had better walk southward along the shore; after a short time will be seen a fine perpendicular section of this particular stratum; we shall notice it is bounded on the one side by the White Chalk, to which it is parallel; on the other by the Speeton clay, which is not conformable to it, that is, not parallel.

The thickness of the bed of the Red Chalk is at this place, as I said just now, about thirty feet. First of all, taking it in descending order, that is to say, having reached its limit at the White Chalk, and retracing our steps in the direction of Filey, we notice about twelve feet of red matter containing serpulæ, and we note that the upper portion of this division is much filled with greyish nodules, showing that the change from the White Chalk to the Red is gradual. Next comes a bed of about seven feet thick, of darkish White Chalk; and finally, another bed of about twelve feet thick, of bright Red Chalk, containing belemnites and terebratulæ. The whole is followed by the Speeton clay, of which a short and accurate account will be found in No. 13 of THE GEOLOGIST magazine. The line of division between these two being well marked by runs of water, which are caused by the percolation through the chalk being stopped by the impervious clay.

The Speeton clay is singular in some of its characteristics. At its upper portion, in contact with the Red Chalk, it contains fossils belonging to the Neocomian or Greensand era, whilst at the lower part there are the representatives of the Kimmeridge clay. And thus it would appear to be one of those peculiar formations which have resulted from a number of beds thinning out, and becoming absorbed into each other. Three of the well-marked fossils of the Speeton clay may

be adduced : *Belemnites jaculum* ; a small crustacean, *Astacus ornatus* ; and a large hamite, called *Hamites Beanii*.

To the south of the Red Chalk at Speeton, and adjoining it, occurs, as I lately mentioned, the White Chalk. The fossils in this part are not numerous ; an inoceramus, a terebratula, and rarely an ammonite, are found. But the White Chalk higher up, that is, farther south, below Flamborough Head, near Bridlington Quay, is very fossiliferous, containing corals, echini, a bed of marsupites, as well as that very remarkable and extensive collection of marine forms, the silicified sponges, thousands of which can be seen at low water scattered up and down, and imbedded in the scars, or rocks. This chalk, however, has its drawbacks, for being very hard—indeed, so much so as to ring under the strokes of a hammer—specimens cannot be obtained without much trouble. I must make an exception with regard to the sponges. They are composed of silex ; hence, long soaking in very dilute hydrochloric acid will do more and better work after the fossils have been brought home, than fifty chisels. The calcareous matter is slowly dissolved away, and then forms come into view as delicate and lovely as any that can be noted in the modern sponge tribe. Most of the common kinds of the Flamborough sponges will be found figured and named in Professor Phillips' *Geology of Yorkshire* ; the rarer in the *Magazine of Natural History* for 1839.

Let us now return to the village of Speeton, and endeavour to follow the winding course of the Red Chalk to its visible termination, some hundred miles to the south-east, in the county of Norfolk.

By a reference to the map (page 2), where the bed is laid down, it is seen that the Red Chalk adjoins the White Chalk during its entire length ; that it first takes a westerly direction for about twenty miles, and then suddenly turning at a sharp angle proceeds south-east for the remainder of its course.

Some persons might suppose when they see the map, that if they were to travel to any of the towns or villages near the line, they would of necessity be able to see the Red Chalk *in situ*. No such thing ; the upper soil, or vegetation, or man's work, may quite conceal all traces. It is only at natural sections like the cliffs just spoken of, or by other means, such as wells, &c., that we can acquire a true idea of the ground beneath us. Who, for example, that lives

in the City of London, could imagine, unless he had seen the fact for himself, when sewers were opened, or foundations cut, that he was dwelling over beds of gravel as bright and yellow as any that cover the paths of a flower-garden?

When, therefore, the nature of the surface of the ground is such that the eyes cannot detect traces of any particular formation we may be in search of, we must seek other testimony, we must ask what have other men seen, and what have they recorded, and in whose custody have they placed the keeping of those facts.

In the present case I can refer to two excellent works, to help us,—Professor Phillips' Geology of Yorkshire, and Young and Bird's Survey of the Yorkshire Coast.

Let us turn to the latter. The authors write that in the year 1819 a Mr. George Ravis, of Sherburn, bored for coal in a deep dale about a mile and a half south of Staxton; the boring was continued for some considerable depth. First they passed through the White Chalk, next came upon the Red seam, and finally, at the depth of 288 feet from the mouth of the bore, reached the Speeton clay. Thus then near Staxton, a few miles west of Speeton, the Red Chalk exists; there it is, though it may not be visible.

If we proceed still farther west along the northern foot of the Yorkshire Wolds, it is possible that at Knapton we shall actually see the Red and White Chalk again *in situ*; for Young and Bird tell us that, at a clay-pit near that village, it was to be seen in their day. At North Grimston, they add, the coloured chalk seems to be wanting, for at a copious spring issuing on the hill-side, about a mile above the village, the White Chalk is seen lying immediately over the blue clay.

This statement is not to be wondered at. Look at the map (page 2). Not far from North Grimston there must evidently be great unconformity of strata. Notice several of the formations, instead of running parallel to one another, actually are at right angles. For instance, we have the Speeton clay, the oolites, and the lias, almost perpendicular in direction to the White Chalk, a little to the west of Great Driffeld. Such a condition of affairs must have resulted from great disturbances, and there would be nothing strange in a part of the series being displaced or altogether wanting.

Some miles to the south, near the town of Pocklington, the strata

are again parallel in direction to each other, and accordingly the Red Chalk is found, as before, at the base of the Wolds. Professor Phillips, in his work on the Geology of Yorkshire, figures some Red Chalk fossils from Goodmanham, near Market Weighton, and alludes to their also occurring at Brantingham, not far from the River Humber, the boundary of the county.

Thus, then, the Red Chalk has been traced through Yorkshire ; speaking roughly one might say, that it for the most part takes an undulating course at the base of the Wolds ; that it rises with a very gentle inclination from the sea near the village of Speeton ; that it proceeds nearly due west until it approaches the neighbourhood of Malton, that it then suddenly changes its direction, and advances south-east until it sinks below the marsh-land six or seven miles to the west of Hull, having occupied a distance of about fifty miles.

We now cross the river Humber, and find the Red Chalk again near the banks at a place called Ferraby, to the west of Barton in Lincolnshire.

The Museum of the Geological Society of London possesses specimens taken from that part, and in a note attached to them there is this remark, that first came White Chalk, then Red Chalk, then a blue clay ; thus it is evident there is the same state of things prevailing as we had at Speeton ; and the same observation will apply to the appearance of the specimens themselves.

But as we travel along the western base of the Lincolnshire Wolds, or Chalk Downs (for Londoners would so term them), although we find the Red Chalk underneath the White, yet the blue clay beneath the Red Chalk is wanting ; its place is supplied by a thick series of brown coloured sands, with included beds of sandy limestone, full of fossils like the Kentish Rag, only not possessing echini and belemnites. These beds have been referred to the lower greensand.

Only a few remarks can be offered in reference to Lincolnshire. My intention was to have visited the base of the chalk-hills, and have gathered together new facts ; I have not been able to do so ; neither have I been successful in discovering any authors who have written much about that county. There is a great geological darkness over that land, and much remains to be done in working out its fossiliferous deposits. I can, however, speak confidently regarding Louth.

One might fancy, as the town is placed to the right of the dark line on the map, which marks the position of the Red Chalk, that Louth could have nothing to do with the latter. But a friend who made some inquiries for me on the spot has forwarded two specimens, and says he saw them taken out of a chalk-pit at that town. They ran in veins, he writes, the lighter coloured over the darker, and were dug at no great distance below the surface. The bright red piece was just above where the springs arise—facts which correspond with evidence in other places.

As the inclination of the plane of the strata is small, and rising towards the south-west (the direction of the strata being north-west), it is easily comprehended that the Red Chalk may exist under Louth, and yet not appear at the surface of the ground until at some distance to the west of the town.

At Brickhill, near Harrington, the seam also has been met with ; a specimen of it can be seen in the Museum of the Geological Society of London. This last and those from Louth differ little in appearance or character from what may be obtained at the Speeton beds.

I have no more to say about Lincolnshire, except that, according to the authority of geological maps, the Red Chalk of that county sinks and disappears below the marsh-lands, a few miles before reaching the sea.

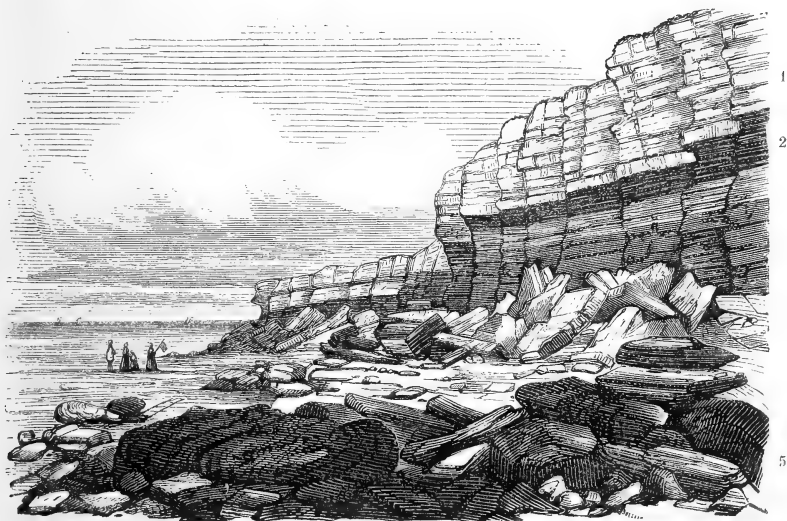
And now it is time to cross the Wash, that great sea-bay, and land at Hunstanton, a little village on the north-western coast of Norfolk. As I am addressing a company of working geologists, I ought perhaps to say how in practice the locality can be arrived at, for it is not quite so easy to reach a place in reality as it is to see it on a map.

To go to Hunstanton, in the most ready way, a person must first reach Lynn ; whence an omnibus, starting in the afternoon, at three or four o'clock, from the Lynn station, will convey passengers to the village.

At Hunstanton there are two hotels, and several lodging-houses. I should recommend the Le Strange Arms, as being an old-fashioned comfortable inn, and nearer than the other to the section we are in quest of. Perhaps it may be thought, Why dwell so much upon Hunstanton—its hotel—and its omnibus ? I do so because at that village there is a most excellent natural section of the Red Chalk,

better almost than at Speeton, and different certainly in many respects.

We will suppose that we have arrived at Hunstanton, and are walking towards the shore in front of the Le Strange Arms. A very few minutes will convey us to the wonderful cliff. I say wonderful, not from its height or length ; for at its greatest height, under the lighthouse, it is not more than sixty feet ; and it extends little more than a mile in length ; but wonderful from its curious colour and general effect.



Lign. 2 .—Hunstanton Cliff (looking to the North).

The woodcut, copied from a water-colour drawing, made last autumn by a friend, will afford an idea of its appearance ; but in it the absence of colour, of course, takes away from the beauty of the scene.

The cliff itself may be divided into five portions : first, White Chalk, forty feet thick ; secondly, bright Red Chalk, four feet ; thirdly, a yellow sandy mass, ten feet ; fourthly, a dark brown pebbly stratum, forty feet ; and, lastly, twenty feet of a bed almost black.

These divisions do not run one into the other, as is the case in most geological strata, but keep quite distinct. Thus the Red Chalk is as clearly separated from the White, as though the one had been covered

by a broad band of paint. The same observation will hold good with respect to the others.

It will readily be understood that when the sun shines upon the cliff, and lights up the bright white, the bright red, the pale yellow, and the dark brown and black, and casts a shadow over the mass of gaily tinted materials at the base, a picture is produced not easy to be surpassed in beauty, and certainly not to be fully appreciated unless it be actually seen.

The bed of White Chalk above the Red is, at Hunstanton, very fossiliferous; though rendered somewhat useless, like that of Yorkshire, to the geologist, from its extreme hardness. Amongst other shells, may be mentioned several kinds of *serpulæ*, *belemnites*, and *ammonites*. These last are occasionally very large: when I was at Hunstanton, in the autumn, I found an example two feet in diameter; with great difficulty I extricated it from its matrix, breaking it in half during the operation; and, finally, had the mortification of discovering that its weight was so great I could not carry it away.

The Red Chalk beneath, which is nearly four feet in thickness, is very full of fossils: *belemnites*, *serpulæ*, *terebratulæ*, corals, and many others, not to mention bones. The number of specimens on the table will testify to its richness in organic remains.

Sometimes it is soft and crumbling; but, generally speaking, it is very hard, gritty, of a bright red shade, and full of small dark-coloured siliceous pebbles; in this respect differing considerably from the Red Chalk of Speeton—in which I have not seen pebbles. Professor Tennant, who has examined the Hunstanton pebbles, informs me that they consist of *chalcedony*, *quartz*, *flint*, *slate*, and *brown spar* or *carbonate of iron*.

It also contains a great quantity of fragments of *inocerami*, and a curious ramifying sponge-like structure (there is one on the table), which also occurs in the White Chalk above.

Something very similar to the ramifying sponge is seen on the surface of blocks on the sea-shore at the back of the Isle of Wight in the greensand formation, and one very like it on the calcareous grit of the Yorkshire shore. You will observe these last to the north of Filey, but nothing of the same appearance exists in the White Chalk at Speeton.

Underneath the Red Chalk of Hunstanton occurs a yellow and brown pebbly sandstone, which was formerly supposed to contain no organic remains. Mr. C. B. Rose of Yarmouth, however, has obtained many.

This bed is termed in those parts "carstone," and much employed as a building-material. The cottages in that neighbourhood and on the road from Lynn seem at a distance as though they had been constructed of masses of gingerbread, so great is the similarity in colour and appearance.

The length of the Red Chalk, from end to end, at the Hunstanton Cliff is about 1,000 yards, and its greatest elevation at the point where it attains the top and quits the cliff is thirty-seven feet ; hence its rise is very gradual, since its first appearance is nearly on a level with the beach.

There are two other things worth observing at Hunstanton. One is the lighthouse, which is upon the dioptric principle, the light being transmitted out to sea by means of glass prisms instead of the ordinary metal reflectors ; and the other is a vestige of a raised sea-beach on the cliffs composed of rounded fragments of White and Red Chalk immediately reposing on the greensand. It is situated at the southward of the point where the Red Chalk crops out.

We will now, if you please, quit Hunstanton, and proceed towards Lynn, keeping in the neighbourhood of the coach-road.

If we could dig up the ground when we were within eight or nine miles of Lynn, we should still see our old companion at our feet, for the Red Chalk has been recognised at the villages of Ingoldsthorpe and Dersingham.

We shall soon meet it no more. At Leziate, a little to the north-east of Lynn, it becomes extinct. Mr. C. B. Rose, who always thought the Red Chalk would prove to be the equivalent of the gault, and who argued from the evidence of fossils and from the direction of the outcrops that the true gault and the Red Chalk must ultimately meet,—Mr. Rose, I say, has informed me that he has observed the Red Chalk and the gault incorporated together at Leziate. Henceforward to the south the Red Chalk is no more seen.

Thus, then, we have come to the termination of our journey. We have noted the beginning and the ending of the Red Chalk, we have

also taken some account of its neighbours. We have noticed, too, that in Yorkshire it for the most part reposes on the Speeton clay, though in certain localities it is next the lias and Kimmeridge clay, and that in Lincolnshire and Norfolk it rests on a dark brown pebbly mass supposed to belong to the lower greensand formation of the south of England.

The Red Chalk has also been discovered in a very unexpected place, although not *in situ*. I allude to the drift of Muswell Hill. In that collection of different materials, comprising examples from every formation from the London clay to the mountain limestone in a stratum of eighteen feet, the Red Chalk has been seen in a bouldered condition.

By the kindness of Mr. Wetherell of Highgate, I am enabled to exhibit specimens from the drift of Muswell Hill. Any person who compares them with others from Hunstanton, would declare they came from the same bed, so alike are they in appearance.

There was a time no doubt when this Red Chalk had a more extended range: its presence in the drift of Muswell Hill, as well as in the drift of other places, implies as much. Perhaps it may still exist elsewhere, deep down in the earth.

In a well sunk at Stowmarket a red substance was found under the White Chalk, at a depth of 900 feet; and in another well sunk at Kentish Town, the workmen met, at a depth of 1,113 feet below the surface, beneath the gault, a bed of red matter 188 feet thick—some of this red matter appeared to contain belemnites.

Geologists are divided in opinion with respect to this deep-sunk red bed, which certainly is not always continuous (for instance, it was not found at a boring at Harwich), and some incline to the opinion that it belongs to the New Red, others that it is the equivalent of what is styled the Red Chalk. But it is difficult to give a solution at present. It is certain that in the gault formation, or near it, beds of a red colour are occasionally found. Near Dorking the lower greensand is capped by a local bed of bright red clay, eight feet thick. And examples of red clays from the gault of Ringmer in Sussex and Charing in Kent can be seen in the Museum of the Geological Society of London. Whether they have any relation with the Red Chalk proper of England depends upon the position which is given to that formation.

Geologists generally consider the Red Chalk as really equal to the Gault. Many of the fossils certainly are gault species; others no doubt belong to the Lower Chalk; and, therefore, probably it is better to regard it as an intermediate formation between the Lower Chalk and the Lower Greensand, which comes into being when the Gault and Upper Greensand have almost thinned out.

One of the members of our Committee, Mr. Rickard, has been good enough to make me an analysis of the Red Chalk of Speeton and Hunstanton. The Speeton is as follows:—

Carbonate of lime, with a little alumina	81.2
Peroxide of iron	4.3
Silica	14.5
	<hr/>
	100.
	<hr/>

From Hunstanton—

Carbonate of lime, with a little alumina	82.3
Peroxide of iron	6.4
Silica	11.3
	<hr/>
	100.
	<hr/>

The latter of which agrees remarkably well with the colour of the specimen, for the Red Chalk of Hunstanton is brighter than that of Speeton.

Two specimens of the borings of Kentish Town, one a red argillaceous and the other a siliceous mass, gave the following results:—

Argillaceous—

Peroxide of iron	6.5
Carbonate of lime	13.5
Silica and alumina (chiefly the latter)	80.0
	<hr/>
	100.
	<hr/>

Siliceous—

Peroxide of iron	2.5
Carbonate of lime	23.5
Silica, with a little alumina	74.0
	<hr/>
	100.
	<hr/>

Whether any connexion can be traced between these last two and the two former, I leave for others to decide.

The following list of books may perhaps be useful to those who wish to further investigate the subject :—In

Professor Phillips' *Geology of Yorkshire*,
 Young and Bird's *Survey of the Yorkshire Coast*,
 Dr. Fitton's *Memoir of the Strata below the Chalk*,
 Taylor's *Hunstanton Cliff* (*Phil. Mag.* vol. lxi.),
 Woodward's *Geology of Norfolk*,
 Rose on the *Geology of West Norfolk* (*Phil. Mag.* for the years 1835 and 1836),

will be found some account of the English Red Chalk. And in

Sedgwick and Murchison on the *Structure of the Eastern Alps* (*Geol. Soc. Trans.* vol. iii. Second Series),

Sir. R. I. Murchison on the *Geological Structure of the Alps* (*Quart. Geol. Journal*, vol. v.),

Prof. T. A. Catullo on the *Epiolitic Rocks of the Venetian Alps* (*Quart. Geol. Journal*, vol. vii.),

Count A. de Zigno on the *Stratified Formations of the Venetian Alps* (*Quart. Journal Geol. Soc.* vol. vi.),

will be seen an outline of the Scaglia or Red Chalk of Italy.

By the kindness of Dr. Bowerbank, Messrs. Wetherell, Bean, Leckenby, and Rose, in permitting me to see the specimens in their respective cabinets, and to whom, as well as to Mr. Rupert Jones, I must express great obligations for much valuable information, the accompanying list of the Red Chalk fossils of Speeton, Hunstanton, and Muswell Hill has been compiled. To the Council of the Geological Society, I am also indebted for permission to figure from the Society's Museum the *Inoceramus Crispus*, on pl. i. fig. 4.

LIST OF FOSSILS FROM THE RED CHALK.

	Speeton.	Hunstanton.	Muswell Hill.
<i>Cristellaria rotulata</i> , D'Orb. Pl. II. fig. 8	×		
Sowerby's Min. Conchology, tab. 121, page 45. (In the collection of Mr. Jones.)			
<i>Siphonia pyriformis</i> . Pl. II. fig. 2		×	
Goldfuss Petrifacta, tab. 6, fig. 7, page 16. (In the collection of Mr. Rose.)			
This is probably the head of the next.			
<i>Spongia paradoxa</i> . Pl. II. fig. 1		×	
Geol. Trans. 2, tab. 27, fig. 1, page 377. (In the collections of Mr. Rose and Author.)			
<i>Bourgueticrinus rugosus</i> . Pl. III. fig. 5		×	
D'Orbigny's Hist. des Crinoides, tab. 17, fig. 16—19. (In the collections of Mr. Rose and Author.)			
<i>Pentacrinites Fittonii</i>	×		×
Austin's Crinoids, page 125. (In the collections of Mr. Rose, Author, and Mr. Wetherell.)			
<i>Cardiaster suborbicularis</i> , Forbes. Pl. II. fig. 3		×	
Gold. tab. 45, fig. 5, page 148. (In the collections of Mr. Rose and Author.)			
Mr. Rose's specimen is far better than the one figured.			
<i>Cidaris Gaultina</i> (?), Forbes, Dec. v. Pl. III. fig. 7		×	
(In the collection of Mr. Rose.)			
Spines with 8 ridges, 10 ridges, and 20 ridges		×	×
(In the collections of Mr. Rose and Mr. Wetherell.)			
<i>Diadema tumidum</i> , Forbes, Dec. v. Pl. III. fig. 6		×	
(In the collection of Mr. Rose.)			
<i>Serpula antiquata</i> . Pl. III. fig. 4		×	
Sow. Min. Con. tab. 598, fig 4, page 202. (In the collection of Mr. Rose.)			
<i>Serpula irregularis</i> . Pl. III. fig. 3		×	
(In the collection of Author.)			
<i>Serpula triserrata</i> . See notice, page 18		×	
(In the collection of Mr. Rose.)			
<i>Vermicularia umbonata</i> . Pl. III. fig. 2		×	
Mantell's Geol. of Sussex, tab. 18, fig. 24, page 111. (In the collections of Mr. Rose and Author.)			
<i>Vermicularia elongata</i> , Bean MS. Pl. III. fig. 1, 1 ^a	×		
(In the collections of Mr. Bean, Dr. Bowerbank, and Author.)			
<i>Cytherella ovata</i> , Römer. Pl. II. fig. 7	×		
Jones, Cretaceous Entomostraca. Pal. Soc. page 29. (In the collection of Mr. Jones.)			
<i>Idmonea dilatata</i>	×		
D'Orbigny's Terrains Crétacés, tab. 632. (In the collection of Mr. Bean.)			
<i>Diastopora ramosa</i> , Dixon		×	
Geol. Suss. page 295. (In the collection of Mr. Bean.)			

	Specton.	Hunstanton.	Muswell Hill.
Ceriopora spongites	×		
Goldfuss, page 25, tab. 10, fig. 14. (In the collection of Author.)			
Terebratula capillata. Pl. IV. fig. 4, 4 ^a , mag. surface . . .		×	
Davidson's Cretaceous Brachiopoda, plate 5, fig. 12, page 46. (In the collections of Mr. Rose and Author.)			
Terebratula biplicata. Pl. IV. fig. 1, 1 ^a , mag. surface . . .		×	
David. plate 6, fig. 34. (In the collections of Dr. Bowerbank, Mr. Rose, and Author.)			
Terebratula Dutempleana		×	
David. plate 6, fig. 1. (In the collection of Mr. Rose.)			
Terebratula semiglobosa. Pl. IV. fig. 2, 2 ^a , mag. surface . .	×	×	
David. plate 8, fig. 17. (In the collections of Dr. Bowerbank, Mr. Bean, and Author.)			
Kingena lima. Pl. IV. fig. 3, 3 ^a , mag. surface		×	
David. plate 5, fig. 3, page 42. (In the collections of Mr. Rose and Author.)			
Avicula, cast of. (In the collection of Mr. Bean.)	×		
Exogyra haliotoidea Pl. II. fig. 10		×	
Sow. M. C. tab. 25, page 67. (In the collections of Mr. Rose and Author.)			
Inoceramus Coquandianus. Pl. I. fig. 1	×		
D'Orb. Ter. Crét. tab. 403, fig. 6—8. (In the collection of Author.)			
I. Crispii. Pl. I. fig. 4		×	
Mant. G. S. tab. 27, fig. 11, page 133. (In the collections of Mr. Rose and Geol. Soc.)			
I. tenuis. Pl. I. fig. 5		×	!
Mant. G. S. page 132. (In the collections of Mr. Rose and Mr. Wetherell.)			
I. gryphæoides		×	
Sow. M. C. tab. 584, fig. 1, page 161. (In the collection of Mr. Rose.)			
I. læviusculus, Bean	×		
(In the collection of Mr. Bean.)			
I. sulcatus		×	
Sow. M. C. tab. 306, page 184. (In the collection of Mr. Rose.)			
Ostrea frons. Park. Pl. II. fig. 4			×
Sow. M. C. tab. 365, page 89. (In the collection of Mr. Wetherell.)			
O. vesicularis, Lam. Pl. II. fig. 5		×	
Sow. M. C. tab. 392, page 127. (In the collection of the Author.)			
O. Normaniana		×	
D'Orb. tab. 488, fig. 1—3, page 746. (In the collection of Mr. Rose.)			

	Specton.	Hunstanton.	Muswell Hill.
<i>Pecten Beaveri</i>	x		
Sow. M. C. tab. 158, page 131. (In the collection of Mr. Rose.)			
<i>Spondylus latus</i>	x	x	
Sow. M. C. tab. 80, fig. 2, page 184. (In the collection of Mr. Rose and Author.)			
<i>Ammonites alternatus</i> ?		x	
Woodward, Geol. Norfolk, tab. 6, fig. 23.			
<i>Ammonites complanatus</i>		x	
Sow. M. C. tab. 567, fig. 1. (In the collection of Mr. Rose.)			
<i>A. rostratus</i>		x	
Sow. M. C. tab. 173, page 163. (In the collection of Mr. Rose.)			
<i>A. serratus</i> , Parkinson		x	
Sow. M. C. tab. 308, page 3. (In the collection of Mr. Rose.)			
<i>Belemnites attenuatus</i> . Pl. IV. fig. 5		x	
Sow. M. C. tab. 598, fig. 2, page 176. (In the collection of Author.)			
<i>B. minimus</i> . Pl. IV. fig. 8	x	x	x
Sow. M. C. tab. 598, fig. 1, page 175. (In the collections of Messrs. Bowerbank, Bean, Rose, Wetherell, and Author.)			
<i>Belemnites Listeri</i> . Pl. IV. fig. 6	x		
Phil. Geol. York. tab. 1, fig. 18. (In the collection of Author.)			
<i>B. ultimus</i> , D'Orb. Pl. IV. fig. 7	x		
Sharpe, Chalk Moll. tab. 1, fig. 17. (In the collections of Mr. Bean and Author.)			
<i>Nautilus simplex</i> . Pl. I. fig. 3		x	x
Sow. M. C. tab. 122, page 122. (In the collections of Mr. Rose, Mr. Wetherell, and Author.)			
<i>Otodus appendiculatus</i>			x
Ag. vol. iii., page 270, tab 32. (In the collection of Mr. Wetherell.)			
Tooth of Saurian	x		
(In the collection of Mr. Bean.)			
<i>Vertebra of Polyptychodon</i> (?)		x	
(In the collection of Author.)			

Siphonia pyriformis is probably the head of *Spongia paradoxa*. In the cabinet of Mr. Rose is a mass of the latter, to which a head similar to the one figured is attached.

Bourgueticrinus rugosus. The diameter of the specimen figured is $\frac{5}{8}$ of an inch, the depth of each plate $\frac{3}{16}$. The surface of attachment is covered with very fine mamillæ, in rays of seven in number; a smaller specimen in possession of the author measures $\frac{2}{3}$ of an inch in diameter and $\frac{1}{4}$ in depth.

The serpula represented in Plate III. fig. 3 varies in its irregular growth from the specimens figured on the same plate. This character perhaps can scarcely be regarded as a specific difference; both *V. elongata* and the serpula under con-

sideration have the same thickness of the calcareous tube. The former occurs only at Speeton and the latter at Hunstanton; in order to distinguish the two, the title "*irregularis*" may be applied to the latter as a variety.

Serpula triserata, a species found on a specimen of *Ammonites complanatus*, is distinguishable by its three serrate longitudinal ridges. A similar form occurs on ostrææ from the Kimmeridge clay of West Norfolk.

Terebratula semiglobosa is common at Speeton, but very rare at Hunstanton. *T. biplicata* is very common at Hunstanton, but is not known at Speeton.

Inoceramus læviusculus, Bean, a large smooth species something like *I. Cuvieri*.

The *Ammonites alternatus* of Woodward is now lost; it was probably a variety of *A. serratus*, Park.

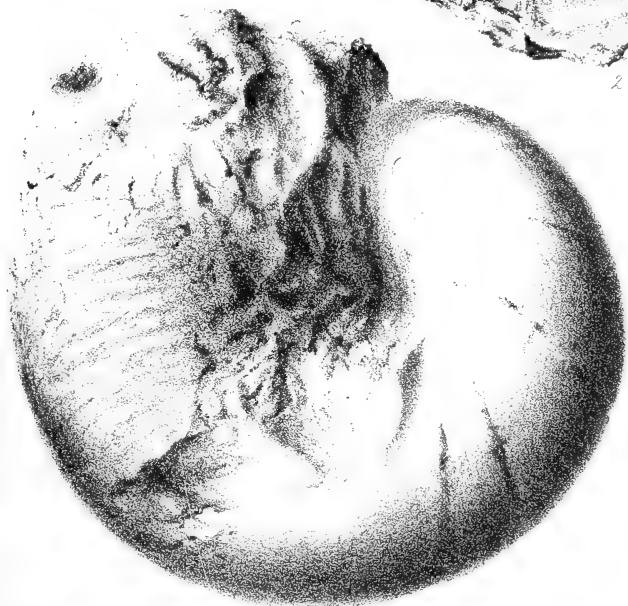
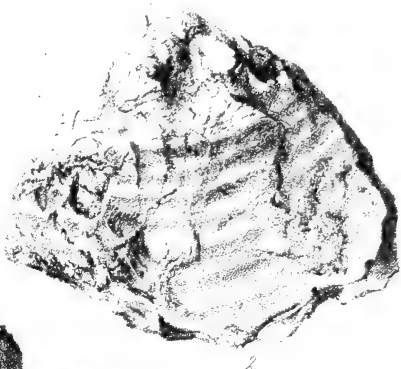
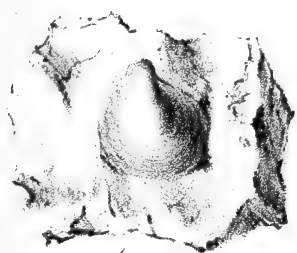
Belemnites minimus is sometimes two inches long in the Hunstanton Cliff.

The vertebra of *Polyptychodon* would be, if perfect, about six inches in diameter and three in thickness.

The small specimen shown in Plate II. fig. 9 evidently belongs to the Turbinoïan family of corals, and possibly to the genus *Trochocyathus* instituted by Messrs. Milne-Edwards and J. Haime, in 1848. The specimens as yet obtained are not sufficiently numerous nor perfect for a rigid comparison with other forms, or to admit of a sufficiently detailed description should the species prove to be new. The constricted form of growth is very common in the *Parasmilia* of the Upper Chalk, and has no specific value.

The characteristic fossils of the Red Chalk at Speeton are *Terebratula semiglobosa*, *Belemnites minimus*, and *Vermicularia elongata*; and at Hunstanton, *Terebratula biplicata*, *Belemnites minimus*, and *Spongia paradoxa*.

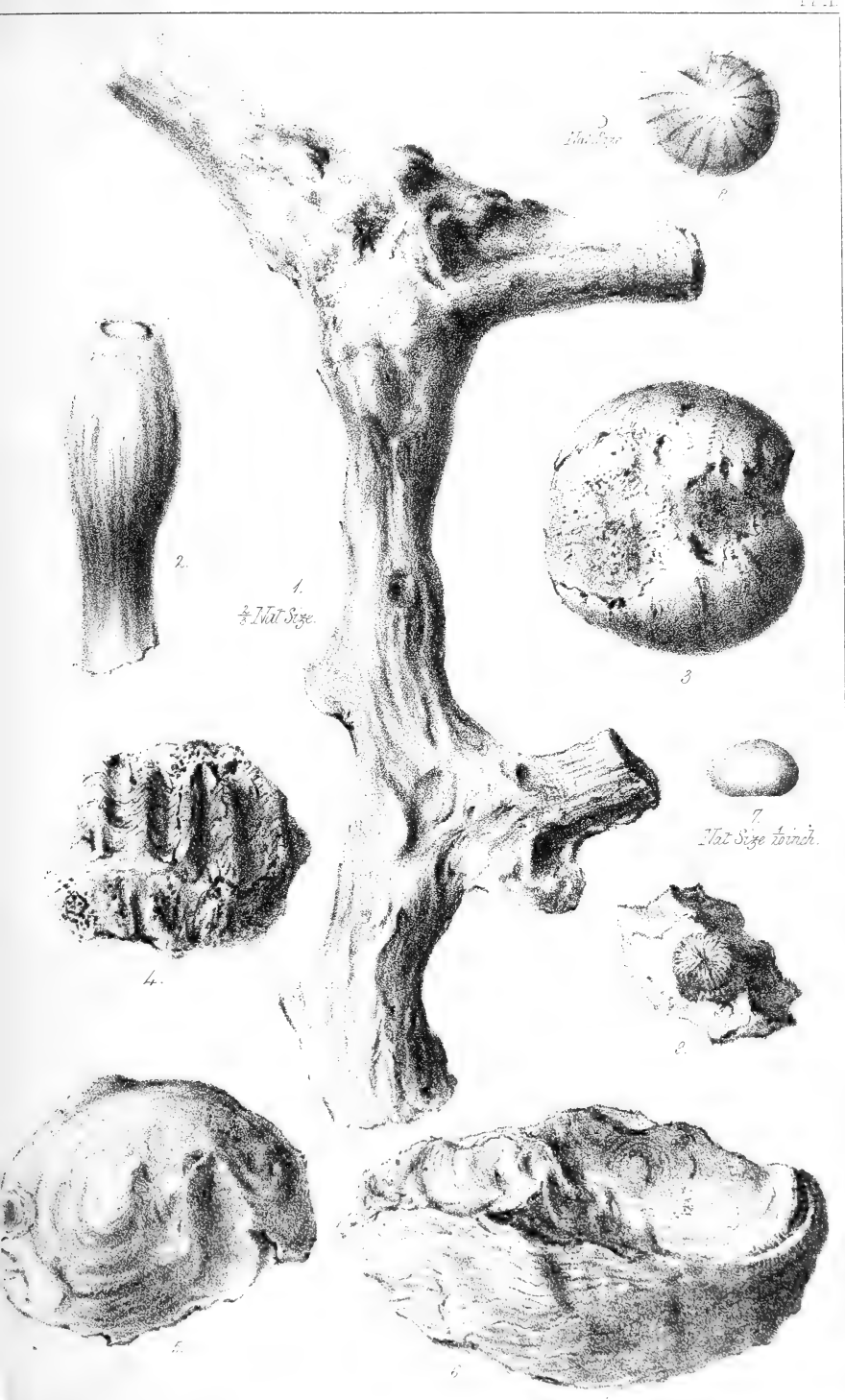
In conclusion, I have endeavoured all along to confine myself to facts, and to abstain from theories, because I think the Geologists' Association ought rather to follow in the steps of learned men than to wish to take the lead. I am sure by doing so we shall gain respect. If the strictly scientific workers see we wish to acquire information, rather than to purchase an empty name, they will hold out the right hand of fellowship and help us mightily; whilst, on the contrary, if they perceive we aspire too much, and attempt to grasp what we cannot hold, then well-merited ridicule will undoubtedly be ours. The Geologists' Association was only formed to bring amateurs together, to give them a place to meet in, and a room where they could speak on kindred subjects. I trust the members will always use the opportunity, and not be afraid to speak, ever remembering that each one has some little knowledge which his neighbour has not, and that when each helps his fellow, much must be the gain at last.



3.
2/3 Nat. Size





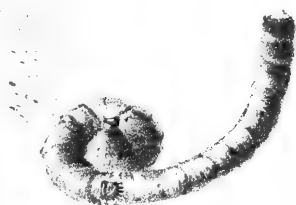


1/2 Nat Size

1.
1/2 Nat Size

7.
Nat Size 1/4 inch





1.



1a



3.



2.



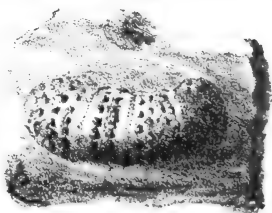
4.



5.



7.



6.





1.



2.



1^a



2^a



6.



7.



5.



8.



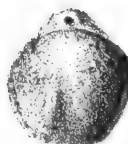
1^a



3^a



4.



3.





3

The Geologists' Association.

ON

SOME PECULIAR MARKINGS

ON THE

BROKEN SURFACES OF FLINTS.

BY

N. T. WETHERELL, Esq., M.R.C.S.,
OF HIGHGATE.

A PAPER READ AT

THE ORDINARY MEETING,

6TH JUNE, 1859.

LONDON :

PRINTED FOR THE ASSOCIATION,

AND

PUBLISHED AT THE OFFICE OF "THE GEOLOGIST," 154, STRAND.

1859.

Presented by P. B. Woodward Esq; 21. 11. 88



On some Peculiar Markings occurring occasionally on the Broken Surfaces of Flints. By N. T. WETHERELL, Esq., M.R.C.S., of Highgate.

The appearances to which I call attention consist of a series of very fine, variously-curved lines, generally placed one above the other, the series being sometimes branched. The lines are about the thickness of a hair, and often so closely set, that, in the space of an inch, as many as fifty have been counted. They vary in form from circular to an oval, and I have occasionally seen some which have been waved. It sometimes happens that these lines are very irregularly grouped together, as if a small handful had been taken up and sprinkled over the surface of the flint. They for the most part assume a dark colour; and I have two examples which are highly ferruginous. I was disposed at one time to consider these markings to be of organic origin, but not having detected any structure under the microscope, and having also observed similar appearances in dried paint which had been spread upon wood, I think it is not improbable that they are *inorganic*. The flints which I have examined are from the gravel-pits in the vicinity of Highgate; and I shall have much pleasure in depositing some specimens in the Museum of the Geological Association.

I will now briefly advert to some appearances in broken flints, which are clearly due to fracture, and which I consider bear some slight analogy to the markings above described.

If the broken surface of a flint which has been smartly struck once or twice with a hammer be examined, there will be detected, in some instances an arrangement of curved lines. On viewing these appearances one is naturally led to contemplate in what manner they are produced. May it not be due to the tendency of siliceous matter to assume a circular form under certain conditions?

I trust this matter will be discussed, as I should much like to hear the opinion of Mineralogists on the subject.

REFERENCE TO PLATE*

1. Series of Curved Lines.
- 1*a*. Waved Lines.
2. Irregularly Grouped Curved Lines.
3. Series of Oval Lines produced by Fracture.
4. Series of Curved Lines produced by Fracture.

* These representations are all enlarged.

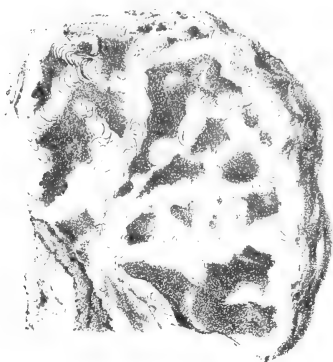


Fig. 1. Mag. 2 diam.



Fig. 3. Mag. 2 diam.

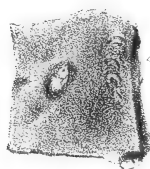


Fig. 4. Nat. size

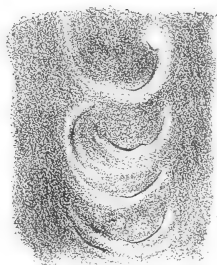


Fig. 4. Mag.

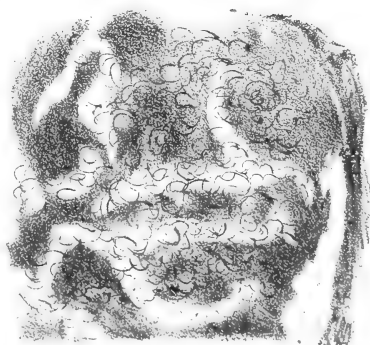


Fig. 5. Mag. 2 diam.



157
4
The Geologists' Association.

THE FINDING OF TRUE FACTS:

BEING AN

INAUGURAL ADDRESS,

DELIVERED AT THE

FIRST MEETING OF THE ASSOCIATION,

ON THE

11TH JANUARY, 1859.

BY

TOULMIN SMITH, Esq.,

BARRISTER-AT-LAW,

PRESIDENT OF THE ASSOCIATION.

PRINTED FOR THE ASSOCIATION

BY JOHN EDWARD TAYLOR, 10, LITTLE QUEEN STREET,
LINCOLN'S INN FIELDS.

1859.

25 Feb 1859

_ The Association is not responsible for opinions expressed
in the Papers read at its Meetings.

THE FINDING OF TRUE FACTS.

AN INAUGURAL ADDRESS.

It is not given to man, in following out any branch of natural science, to draw the line of theoretical completeness, and to say to the searcher after truth:—"Hitherto shalt thou come, but no farther." It is, on the other hand, one of the happiest results of true science, that it raises the perpetual wish for fresh inquiry. The completest theories are most easily shaped when there is the least knowledge. Philosophical systems are not difficult to build up, when you have only a few facts to account for, and are not in much fear of others being thrust in your way which may not harmonize with your system. In old times, there were "Philosophers" enough, in this sense; and there was no lack of systems and schools,—each of which had followers who denounced the rudeness of every daring intruder, and found that by far the most convenient method to answer the questioner was by the curled lip and self-sufficient sneer. Modern times, and even our own days, abound in such philosophers, quite as much as the days when the Porch and the Grove were frequented at Athens. But the happy difference is this:—that these philosophers cannot now get the exclusive hearing; but, however wedded individuals may be to any darling theory, and however jealous a self-constituted coterie may be of intruders upon ground which they would fain hold appropriated as their own domain, the door is now open to all, to seek truth and pursue it, and to question Nature and grapple with her secrets:—and theories, however cherished, and jealousies, however narrow, must, in the end, fall before the accumulated light brought to bear by persevering searchers.

It is not the most laborious and successful searcher who is the most disposed to theorize, or the readiest to quarrel with the fruits won by a fellow labourer. On the contrary, it is your men of small grasp and little range that are ever the quickest to shape a theory, and the most positive to maintain it. The firmer the grasp of the real facts of nature, and the wider the range of inquiry into these, the more cautious becomes the daring of the generalizer; and the more strongly does he feel the importance of two things:—*first*, that as many facts as possible shall be collected, by which every generalization shall be tried; and *second*, that every fact got shall be a *true* fact. The latter is a point often not enough considered, and which I shall more fully touch on presently,—content with now reminding you that it has been said, with great justness, that there are even more false *facts* than there are false *theories* in the world.

Geology is a science that rests exclusively on a knowledge of the outer world, and can only consist, as a science, in the true interpretation of the facts which that world shows to us. There is no science to which what I have said as to theories can more thoroughly apply; and there is no science which has been, and is liable to be, more hindered by *false facts*. There is none, therefore, in which the gathering up of true facts, and the bringing these together as a common stock for the use of science, can be more needed. A well-known geologist, writing to me, a few days ago, says:—"I believe we want workers, not theorizers; men who will bide their time, and not propounders of pretty theories, for self and immediate glorification. Much remains to be done in careful work, and well directed energy." The man whose life is passed on some outlying corner of the lias or the coal-formations, and who sees only the special class of facts that surround him, may be very apt to indulge himself in shaping theories. Enlarge his scope,—make his gatherings part of an accumulated store taken from a much wider field; and you check, at once, the disposition to theorize, and teach him that the first truth, and the most necessary of all to be learned,—but perhaps the most difficult,—is, that no fact can be known to be a true fact till its relations have been studied; for that there is no one fact in all physical nature, any more than in man's moral and social nature, which can stand by itself,—naked and alone,—but that the qualities of every fact, and therefore whether this or that statement of it is a

true or a false fact, depend entirely upon the relations in which it stands to other things.

What I have said is enough for me now to take as ground for the work set to itself by the Association whose opening meeting we hold this evening. Instead of any apology being needed for the forming of such an Association, or of those who have taken part in its formation having reason to give any other heed than a passing smile to the jealousies which, unworthily to themselves, some men have indulged in at the boldness of this attempt, it is matter of surprise that it has been so long delayed. Geology is a study which cannot be followed merely in the laboratory or the closet; nor can the growth and development with which it deals, be watched among groups collected by the traveller, and brought together in the garden or the menagerie. It can be learnt only in the field. The very power to judge rightly of its facts, and to marshal them in available order, must be got in the field. Not, of course, that every man must himself have travelled over every "Formation," before he can understand Geology. But, in order to bring home to the mind the bearings of observations made upon many large groups of the facts that lie within this class, the student must have accustomed himself to a personal knowledge of the appearances and shapes under which rocks and stratifications are actually found beneath the mere outer covering of the earth. Now it is, with the active mind, a great increase to the mere pleasure of travel, or even of rural wanderings, to have an object of interest added to the charm which the landscape gives to the eye. Hence, Geology, so soon as it became known as a science, invoked at once, in every corner, the active curiosity and interest of numbers of those who are accustomed to walk abroad with the open eye. Each of these finds that he can gather something which helps to illustrate, if not to add to, that stock of facts, on the true interpretation of which, by careful comparison, the truthfulness of the science must depend. But even this, though alone enough to make such an Association as the present the natural and almost necessary growth of the pursuit of such a science, is by no means the most important reason for its active existence, nor will be the widest sphere of its usefulness. It is within a very few years, comparatively speaking, that the enterprise of this country has become so extraordinarily developed in the way

of those Public Works which deal with the very conformation and substance of the earth's surface. Canals, railways, docks, works of drainage, and other town improvements, are things which make Geology one of the most important and practical of all the sciences that mark our time. To stop now to point out wherein the science of Geology is necessary in every one of these classes of works, is quite unnecessary. Every one knows that the kind and the dip of the Strata are things on which every work of the sort depends, and in the management and adaptation of which the skill of the engineer is shown. We have not, now, the smallest public work done in a little country town, hardly a building of any pretensions put up, but the Surveyor's or Engineer's report *professes*, at the least, to give one section to the "Geological features." I am sorry to be obliged to say that, while we have thus abundant proof of a knowledge of the importance of this science, such Reports very often contain lamentable proof that the knowledge has halted here. An Association which gives the means of interchanging experience, and of bringing together facts, and comparing these, cannot, therefore, but be of very great public service; while the opportunities which those engaged on works of these sorts have, of observing facts and collecting illustrations, will be far more likely to be made good use of by them when an Association like the present opens its doors to them, than when facts and observations, however carefully made, have little chance of ever doing other than remain buried in the note-book. An impulse may hence be expected to be given to Geological science, that will be of first-rate importance, as well to the verification of conclusions already drawn, as to the settling of problems that are admitted to stand open, and, even further, to the opening of fields which have been as yet little worked—in some cases perhaps hardly suspected to exist. "What we want," says Mr. Salter, in a late number of an able publication devoted to this science,—"*what we want, in the present state of Geology, is abundance of good facts* ; and these can only be collected by the industry of local observers, who will communicate these results in a tangible form, available for the workers on particular subjects. . . . There is no pleasure," he adds, "so great as in working for a definite object, with the certainty that your results, however small, will aid in attaining it. Many a holiday may be most profitably occupied (which would

otherwise be lost) by confining the attention to one bed, or a set of beds, instead of hammering away under a vague impression that something is to be done, though you know not exactly what.”* We hope that, at every meeting of this Association, communications of observed facts will be made by members. The statement of these will appear in the printed minutes of our proceedings; and these, being circulated among all our members, will convey to every quarter some of those means for comparison, and suggestions for research, which are what the Local Geologist most needs, both to encourage and enlighten him.

That an Association like the present was much needed, is perhaps quite enough proved by the fact that, within six weeks after the first private meeting had been held, by a few gentlemen, to talk over the proposal, and without any recourse to the ordinary means of attracting public attention, no less than 150 gentlemen sent their written request to be enrolled as Members—many of them well known in Geological Science. So far, the success of the attempt far exceeds the most sanguine expectations of the founders of the Association. It remains necessary to its success, that what it proposes to do shall be well understood, and carried out with spirit and perseverance.

And here I will glance at a point to which I should not have thought it worth while to allude, did I not know that, even among the wise and good, there are some timid men, who will be needlessly afraid, at times, that there is a ghost behind the chair. It is really quite past the time when there was any need for dwelling on the avowal, that such an Association as the present has nothing to do with “theories of the earth.” Were it not that certain information has reached me, that there do exist benevolent ghost-seers who have already begun to grow pale, I should not have thought it necessary to remind any one that Geo-logy is not Geo-genesy. We have to learn the facts, and to help towards a true generalization of the statement of the relations of the facts, that are to be seen on the earth as we find it. We are not about idly to mystify each other with theories of what took place when the earth was “without form and void.” Mr. Ephraim Jenkinson put that matter on its true footing, when he sagely remarked to the respectable Dr.

* ‘The Geologist,’ vol. i. p. 301.

Primrose, that "the cosmogony, or creation of the world, has puzzled the philosophers of every age." If any member of this Association should attempt to waste our time and wander from our purpose, by dancing through the mazes of so notorious a puzzle, it will be the very simple duty of whoever occupies the Chair which I have now the honour to fill, to remind him that this is not a stage for the display of any theory of the earth's origin that he may happen to patronize; but that, if he has been so happy as to dig out of this veritable earth, as we actually find it, any of those truths which it is always ready to reveal to the patient searcher, we shall be delighted to listen to the story of the finding of his treasures.

The aim of the founders of this Association is, that those who, whether from the intelligent interest which the thoughtful man must always take in the phenomena that surround him, or from the professional pursuits in which they are engaged, are in the habit of searching among and handling the groups of facts which relate to the science of Geology, shall find, here, a means of intercommunication, by which the facts gathered up by each shall be continually recorded, and the relations they have to one another, and to former facts, be able to be continually brought forward and tested. It is for those who are thus actively engaged in looking into Nature, that we exist as an Association. It would be doing a great injustice to the number of intelligent men who satisfy the natural curiosity of the student, by supplying him with specimens for scientific study, if we interfered, in any way, with the mercantile demand that the study of Geology has raised for fossils and rock minerals. The result will, unquestionably, be the reverse: for the extension of the sound study of every subject, always extends the demand for all the means to that study. But it is necessary that no mistake should exist as to the fact that this Association has not the least idea of keeping stores of specimens, to be distributed to its members. Its printed proceedings, besides announcing every fresh finding of hidden treasures, will record every communication received from those among our Members who desire to exchange specimens of one Formation, with which their locality happens to abound, for specimens of other Formations with which they have not the same means of becoming familiar. It will thus be a most valuable assistance to the active collector. The line thus drawn is, however, well marked.

It may happen that some of those who deal in Illustrations of the science may join our Body;—for, happily, there are many who have thus become instrumental in the diffusion of the means of scientific study on account of the love they bear to science. But their becoming members of our Body will unquestionably be *notwithstanding*, and certainly never *because* of, this incident of their occupation. We propose indeed to establish a Museum: but we have no idea of filling our cabinets with the sweepings of the over-crowded cabinets of old collectors. The collections which now exist at the British Museum, and in Jermyn Street, already belong to us all. They have been paid for by our money, and their curators are maintained in their several posts, in each, for our behoof. This Association will be the means of making the value of each of those collections more known than they now are; and thus the labours of those whom we pay to fulfil their duties there, and to whose active assistance we are therefore entitled, as matter of right, will, by-and-by, become more appreciated;—but we have no intention of repeating the folly of filling cellars with valuable specimens which are only accumulated to be hidden. We intend to collect as strict a series of type specimens of each Formation as we are able; and to confine our own cabinets to such a series of type specimens. We hope that, while specimens of all characteristic rocks will appear in their most instructive forms, we shall have the corals and the trilobites of the lowest ocean-bed Formations, together with a full set of those *Terebratulæ* which tell the pretentious parvenu who boasts himself of the Battle Abbey Roll, within how very little a compass is contained the only real aristocrat that is to be found in nature. Though one whose name we all affectionately respect,—I think I may say as much of such a man—Hugh Miller,—is no longer among us, we hope that the Old Red Sandstone may be illustrated by its *Pterichthys* and *Cephalaspis*, and by those beautiful corals which distinguish it from other Formations. The Mountain Limestone none of us can mistake, if we limit it to a few forms among the encrinites, and to the very characteristic shells which it yields in such perfection. In the Coal layers we shall have more difficulty: for where does the material end? Not to mention any other of the forms of past life which it yields, can you wander by a pit's mouth,—nay, can you take up a piece of coal to put it on the fire, or raise a handful of ashes from

beneath the smouldering grate, without finding material for delightful study and most instructive observation? In the Magnesian Limestone and New Red Sandstone we are less likely to be involved in difficulty on this score. But in the Lias and the Oolite—rich in treasures of all kinds—the hoe and the rake must be unsparingly used, or our cabinets will soon get overrun with weeds. The Wealden will not overcrowd us; and should we obtain the entire head of an *Iguanodon*, we shall not object to find a place for it. The chalk, though so abounding in stores of fossil wealth, will be less difficult to deal with than many other formations, as regards type specimens; for no one can mistake its most characteristic and beautiful group—the *Ventriculidæ*, or the more marked forms of its representatives among the oysters, chambered-shells, and star-fish,—not to mention now any other of its very beautiful forms. The Tertiary, in its so markedly different layers, with its own fruits and its shells and its mammals, as well as its numerous forms related to the denizens of the earlier earth, will give more trouble; while the highly interesting Diluvial Beds which overlie it, are rich in an abundance from which we shall, however, with less difficulty, be able to select a few to serve as types. Be the difficulties which we shall thus altogether encounter what they may, our hope is, that we may be able, by degrees, to form a Cabinet which shall be truly typical in its character; and our intention is, that, while we give the means of constant intercommunication between observers in different parts, and so promote the exchange of specimens between our members, what we retain, as the property of the Association, shall be limited to groups that will always be instructive.

I am happy to be able to say—and I hope that this will be accepted as an acknowledgment of several communications—that we have already received, from distant Members of this Association, offers of sets of fossils that will illustrate several of the main Formations.

It is our belief that every member will, from time to time, come across facts that will be interesting to the others; and that, by the unconstrained statement of these at our meetings, and recording them on our printed minutes, comparisons may be made, by actual workers in the field, that will equally throw light upon a correspondent's questions, and instruct all those who are desiring to get at

an actual knowledge of the sort of facts, upon the accumulation of which the science of Geology must be entirely built up.

And here I am led to a branch of the subject from which, though I touch on it with some unwillingness, I do not wish to shrink ;—for I am convinced of its very great importance. I mean the wretched pedantry that disfigures so much of modern so-called science, seeking to cover superficialism by a pompous show of unmeaning words. I do not hesitate to say that one of my own strongest reasons for hailing the suggestion for the formation of this Association has been, that it is quite time that Englishmen, when they deal with science, began to talk English, and ceased to grimace in an unintelligible jargon.

It is well enough perhaps,—at any rate it is politic,—in those countries where true humanity is dead, and where the very breath of human self-respect and freedom is regarded as a pestilence, that great pretensions should be made of State honour done to science. True science is dishonoured, not exalted, by a policy so selfish and so transparent, though, unhappily, so successful. The greater the halo of mysticism and pretence that can be thrown round science, the better the end of the enslavers of the human mind is gained ; for they know that, the more intricately they thus succeed in wrapping the toils of a mock intelligence round the minds of men, the more easily will they succeed in keeping them from being engaged with the worthy thoughts that ennoble the MAN. “ Mere memory is sought to be developed at the expense of understanding, free thought, and creative power ; and thus are instilled passive obedience and blind submission on all political and religious subjects.” It is thus that the young Prussian is taught to imagine himself educated,—and there are some in England whom the delusion of words is unhappily able so to blind that they hold him up and call him educated,—because he is, at a given age, drilled up into a machine capable of no end of parrot repetitions, out of the “ isms ” and the “ ologies ; ” while, of that which alone constitutes *real education*,—the education of the *man*, for the duties of life, as the free citizen of a free state,—he is carefully kept in hopeless darkness ; and there is no country in Europe where this last and only worth-having education is, in any sense or manner, given, except England. But what thus marks the crafty systems of miscalled

education, as applied to the masses, extends its effects to those who follow out the higher branches of science. Not perceiving the snare into which they fall, too easy victims, they play into the hands of the enemies of human thought and human freedom. What ought to be *Science* is made into *Mystery*. And there is far too great a disposition to follow this example, (often, perhaps, unconsciously,) in England. This is particularly shown in the language and style that are adopted. I purposely forbear to quote examples: but it must be familiar to every one of you that you can hardly take up a so-called "scientific" book without finding it so interlarded with phrases and words which never were English, and which bear no intelligible meaning, that science is made repulsive, instead of attractive, by those who profess to be the masters of it.

True science can be no mystery. A Faraday does not think it beneath his dignity to give popular lectures, on the science which he has illuminated, to a Christmas audience. We do not live in an Egyptian age, when a few self-assuming priests shall have one language which is to be understood only by the initiated, and another which they condescend to employ in converse with the common people. We live in an age when the boast is paraded that science and art are applied to every purpose of common life. Then, Gentlemen, it is high time that science and art shall be taught in the language of common life, and not be smothered by a jargon which is as repulsive to good taste as it is obstructive to the spread of knowledge. The ridiculous jargon into which what is mis-called *scientific* phraseology has got, latterly, to run, is wholly without excuse. It is not Latin and it is not Greek: nay, it is generally as unintelligible to those familiar with both those languages as it is to any one bred only in the vernacular, and often even more misleading to the former than to the latter. It is certain that it is not English. We inherit a language more copious than the Greek ever was, and one which is peculiarly adaptable for the compounding of words; and which, therefore, may be most readily moulded to the expression of new forms of fact and thought. The man who is unable to express, in English, whatever he has of science to teach, stands confessed as simply unready, and as making pretensions to what does not in truth belong to him. Instead of being a man of real science, he is a charlatan, who seeks to disguise the ignorance

that he feels, by an attempt to throw, under cover of fine phrases, dust in the eyes of those who listen to him. It is time that we put off *charlatans*, as the object of our worship, and took to *knowledge* as a thing worth following. When this is done, intelligent men will not tolerate a man who cannot express his ideas in English. Every one will feel that the man is an Impostor, and not a man of *science*, who, if he pretends to have anything to tell, cannot say it in language intelligible to every man of ordinary education, instead of wrapping it up in an unintelligible jargon. It was well said of one of the old Philosophers of Greece, that he, the first, brought down Philosophy from the clouds, and gave it a home in the dwellings of men. We want a Socrates now as much as ever ; and if this Association does any good, not its least claim to respect will be, that it will compel men who pretend to be scientific, to talk less bad Latin and worse Greek, and to try, at least, what they can make of English.

For the use of the unmeaning jargon which, upon the principle *lucus à non lucendo*, has thus, of late years, come into fashion as “scientific,”—that is, to hinder science,—there cannot be the pretence raised that it is a “universal language.” The science of Englishmen is wanted in England, not in France or Germany. It were no excuse, therefore, for using a jargon which is certainly not intelligible in England, even though it were intelligible in France and Germany. But it is no more intelligible there than here. It is purely a repulsive and fantastical pedantry everywhere ; and it is above all things necessary that those who really value science, and desire its diffusion, and wish well to the spread of knowledge, should have the courage to denounce, in the strongest manner, as I feel it my duty, in delivering an Inaugural Address to this Association, most emphatically to do, this most monstrous of the abuses which disfigure the literature of our day.

Certain “terms of art,” as they are properly called, must always be in use. This is but another form of “idiom,” and has no affinity with the jargon of which I have been speaking. Though one who has paid no attention to Geology may not be aware, on the moment, of the sense in which the words “fault” and “dip” are used, in regard to the layers of the earth’s surface, each of those words conveys, at once, some idea to the hearer’s mind ; which a few words

of explanation are enough to make him never forget how to apply to the instances in which the word is used by the Geologist. There is no matter of science which might not be equally illustrated.

If language was given to man, as the great diplomatist declared, to conceal the thoughts, certainly the modern so-called scientific world is very successful in the fulfilment of the end. There is an older and wiser authority who tells us that it is the place of careful art to conceal the show of art. It is plain that this authority is one of those Classics that has not come within the "humane letters" of those who use the barbarous jargon under which what ought to be science is now so often hidden in impenetrable darkness.

It will be well understood that I do not now allude to the attempt at a universal language in Classification. That such a universal language should be used, if possible, for this purpose, is highly important, in order to secure the identification of objects. By all means let Latin be made the chosen vehicle. But it is desirable that there should be some consistency even here. Names newly given should always be descriptive—*descriptive* of the class, and *distinctive* of the particular group to which the individual belongs. Instead of this, how often do we find names given—just to save trouble to the slovenly namer—which are formed by an unpronounceable compound of the name of some obscurity whom it is sought to rescue, thus, from the oblivion that all such vanity deserves.

I shall not be suspected of favouring, in these remarks, the notion that any man who pretends to follow science, may make what changes he likes in names and classification. There is a morality in science as well as elsewhere. No one has a right to disturb or overlook the arrangement given, after full investigation, to a group of objects; unless he who assumes to disturb it can and does produce reasons and proofs that the arrangement thus already given is founded on mistake or untruth. A name once given to an object unnamed before, provided it be a real, that is a descriptive, name, remains the name by which scientific men ought thenceforth to know it. Else, there would be no end to the confusion that would arise. Examples enough and too many might be given, of the confusion which has arisen through the neglect of so sound a rule. This rule is, however, subject to the condition that, if it is shown that the name first given has been given under a wrong impression of the relations of the

object, when those relations have been further studied, and proof is given that the true position of the object is thus better known, it will be necessary to range it in its proper group and place; which may often require that the generic, and sometimes also that the specific, name that has heretofore distinguished it, shall be changed.

It has been thought, in forming the present Association, that many who have opportunities of collecting geological illustrations, will be thus induced to go out into the field, to whom the stimulus to this effort has hitherto been wanting. It may not, therefore, be out of place if, besides offering a warning against falling down in worship before the barbarisms of modern so-called science, I make a few remarks as to the material methods that may best be adopted in the collection of specimens. I shall speak of nothing which I have not myself found, as a collector in the field, to be the most useful.

The hammers which I have found the best in use are those manufactured by Messrs. Knight of Foster Lane, in the City of London. There is one of these in particular, which I take to be the most handy and useful hammer that has been yet devised. Messrs. Knight know it, I believe, as Percival Johnson's hammer. It combines, in one convenient shape, the pick, the hatchet, and the hammer. For the chalk this hammer is invaluable. But it is no less so in working at many other rocks, especially when they are fresh cut, and unhardened (as many soon become) by the weather. Nothing could be better in getting those nearly the most beautiful of geological specimens, the slabs of Dudley limestone. Of course, in working harder and more massive beds, the simple hammer and the chisel must be used. The best sort of hammer in the latter case, is one that is square at one end, and cut down equally on two of its sides to a narrow edge at the other end.

In packing fossils, a mistake is often made, which has spoiled many a good specimen. I allude to the use of cotton-wool. There cannot be a greater mistake. It is pretty well known that, of the most delicate fossils of the chalk, I have, in my own cabinet, the largest collection that exists. The whole of these, with very few exceptions, were got out of the rock by my own hand, and brought home, over long distances, through ground where no railway eased the dangers that beset the carriage. Yet I believe that I never found a specimen damaged in the carriage home. The first rule is,

always, if you can, to get out the rock on both sides,—that is, the fossil and the impression of it,—when it is a delicate specimen:—then tie these two together, strongly and tightly, and wrap the whole in firm, but not too thick, paper. If you cannot get both sides, still avoid cotton-wool as you would the plague. It sticks to the damp fossil, and can never be entirely removed, and it does not protect it at all. Even where such a fossil as a tooth, jaw, or other brittle specimen, is got out quite free from the rock, the only way in which cotton-wool can be safely used, is for you first to wrap the fossil in silver paper, and then enclose it, very loosely, in a soft layer of what is called the “medicated” cotton-wool.* In all other cases, take a piece of paper,—Hugh Miller used to say that there was nothing like a *Conservative Newspaper* to wrap fossils in,—and wrap it upright, and tightly, round the edges of the fossil,—the latter being held at a right angle to the paper. The fossil is thus enclosed in a paper tube, touching it only at the outer edge. Close this tube, in one fold, flat and firm, at the bottom. Draw it gently over at the top, and fold it down, leaving as much of a hollow as you can, close over the face of the specimen. Pack all your specimens closely, side by side, in chip boxes. Of course the heaviest must be put at the bottom. The paper will then be stiff enough to bear a double row without injury, and elastic enough to ensure the whole safe from any injury through the shake of travelling. When you get home, place each on a clean stone, and gently but thoroughly syringe the face of each with clean soft water, applied with a fine garden syringe. Most specimens will come from under this process in a state you would not deem possible;—every edge sharp and clear, and structure plainly seen which you will search for in vain if you do not adopt the method which, from large experience of its use, I recommend. The less delicate fossils do not need such care. But all should be wrapped in paper, with enough folds to save them, by the elasticity of the paper, from injury through the rubbing, in carriage, of one against the other. If a fossil is got from the seacoast, always soak it for a couple of days in soft water, frequently changed. Then bake it in a slow oven, till it is thoroughly dry. You will thus save it from that action of the salt which has ruined so many a

* The “medicated” cotton-wool is the common cotton-wool carded out and freed from the lumps and knots which are found in common sorts.

beautiful specimen. If you see bones or other promising marks at the edge of a broken piece of rock, collect all the pieces you can where it is found; place them in their proper positions, bedded in plaster of Paris, on a tray, or in a box; then clear away from one of the surfaces, till you come down to the face of the fossil of which the broken edge showed the section. Such specimens, when thoroughly cleaned, and bone specimens in general, will be both strengthened and greatly improved in appearance by being washed with gelatine, which is readily done with a large and soft camel's-hair brush.

If a fossil is found broken, or breaks in carriage, nothing is easier than to mend it. Get the pieces perfectly clean and dry. If it is lias or oolite, or other hard rock, use thin hot glue, applied to both surfaces, and these will join perfectly. Never use "cement" of any sort. If it is chalk, it requires that, before using the glue, the dry chalk should be well saturated with thin gum or gelatine, or very thin glue; otherwise the pieces will not hold together long; for the glue, when hard, fastens on to only a thin coat of the chalk, which has so little of binding hold to the rest of the body of the chalk, that it will, with a slight force, come away. Many fine specimens in the British Museum are seen in this state.

At the pits and cuttings, there are often very intelligent men who may be readily taught to know the kind of fossils of which you are in search. Such assistance affords a much more desirable resource than the "dealers" who, entirely uninformed, sometimes spring up in such neighbourhoods. As to the latter, you must always be on guard. The most ingenious devices are had recourse to by them to mislead the unwary. There is a well-known case of a sheep's jaw in chalk being offered for sale by such a dealer. Always look with suspicion on very fine-looking specimens of star-fish, cidaris with spines, ophiura, pentacrinite, etc. Even fishes are not difficult to manufacture. But you must not despise such dealers. You may sometimes get a valuable specimen through their hands, though distorted by the ignorance of the dealer. I obtained, thus, the large limb of the pterodactyle from the chalk, which Professor Owen has figured; but which, when it came to me (having been broken in getting it from the rock), had the parts displaced in a most preposterous manner. The finest specimen of a spine of the Chalk Sharks which I have ever seen, was obtained in the same way, from

a dealer. I saw it had been patched: I soaked it in water, so as to separate the patched-up pieces, and found that the end had been put upside down in the middle, and the middle wrong way upwards at the end; and these ridiculous blunders had been made, notwithstanding that, when it had been well soaked, and the loose chalk all cleaned away, the pieces fitted exactly together in their right places. Tricks of the same sort will be found in Lias specimens, and those from other formations.

It will save much labour if specimens are cut down, before packing, to the smallest size. This requires a knack, and is by no means so easy as may seem. The schoolboy thinks that the carpenter's plane works along almost by itself; he tries his hand, and finds out his mistake. So, to see an experienced hand split a pebble, or chip off a flint, looks very easy indeed. Try it, and the fact is found very different. Description, in a few words, is almost impossible. I will only say that, to chip down a flint, you must use a hammer not too heavy, and must give, with the square end, a short, quick, light blow,—struck rather sloping outwards. If you are handy in this, you will thus get slice after slice with the greatest ease. If your object is only to lighten the mass, it is soon done. If you want to examine the flint, you can thus get chips thin enough to examine with the microscope.

A vast number of beautiful fossils are found, in many different sorts of rocks, both limestone and sandstone, in the inside of moderately sized rounded masses—or *pebbles, but not water-worn*—of a more or less oval form. It may be worth making a remark, as to getting to the inside of these, which will be found universally applicable as to them, and to be of nearly the same value in flints and fragments of rock. Such masses, whether loose pebbles or in rocks, are formed by that holding together of like to like which you may see every day showing itself more or less strikingly in water, quicksilver, and numberless other forms. The attraction is between the particles of the *same material*. If uninterfered with, every mass would be round. But if a long leaf gets enclosed in a forming mass, it interferes with the attraction of like to like,—and this attraction goes on round the edges of the leaf instead of round the centre; and so the body becomes flattened and oval. Another consequence follows; namely, that, where the leaf has fallen, the lime- or sand-stone has

much less fast a hold than between the parts where like has touched like. Consequently, a blow, rightly given, is quite certain to open to you the enclosed fossil, as clean as the oyster-knife does the oyster. Give your blow generally at the end, in the longest diameter of the pebble; and never with the square head of a hammer, but with the narrow edge, so that your blow shall fall on one line. The following this hint may save many a fossil from hopeless breakage. Though there is no such certain guide in many flints, there is generally something to give a hint; and you may always be sure that, be it flint or any hard rock, the least hold-fastening, and therefore the most certain line of breakage, is in the direction where a fossil lies. Thus I found in the middle of a large flint, without any outward mark, one side of a whole jaw, full of teeth.

How wide the range is where the search has to be made for those facts which this Association hopes to gather together, it were impossible for me now to enter on. We have already enrolled members in Peru, in Chili, and elsewhere abroad, besides those scattered over England. The variety of kind and condition, both of organic remains and of rock, is so great,—while knowledge on every one of them is valuable,—that it is to be hoped that the different localities will be well worked up for what each is capable of yielding. We do not expect to turn up in England the entire body of a mammoth, with flesh and skin and hair, as was, fifty years ago, displayed to the marvelling eyes of men in Siberia;—a discovery that cannot but remind one of that old legend of our forefathers' faith, according to which, long before man lived on the earth, the huge beast Audhumla lived, and sustained her life by licking the rime-frost from the primeval salt rocks. But from the Mammoth and the Mastodon, whose remains, though less complete than in Siberia, are in fact widely found in England, to the numberless but not less wonderful little creatures which can be seen only by aid of the microscope, the variety is wide.

I remarked, at the beginning, on the need there is to distinguish between false facts and true ones. This can only be done by noting every circumstance in the conditions and relations of each. It is, first of all, necessary for every man who really loves truth, to be firmly persuaded that he has no right to be a quack: he has no right to pretend to search nature, unless he has first mastered the

principles on which the idea of the UNITY of Creation rests. There is not such a thing as Solitude in nature. As freedom and free institutions do not consist in every man doing exactly what he likes;—but in every man knowing and remembering that everybody else has equal rights with himself, and in those equal rights being equally respected by all;—so, all the facts of every branch of science are more or less intimately related to each other; and, unless the Relations of every alleged fact be well considered, the statement of it will turn out to have been, not the statement of a truth, but of a false fact,—one which will be delusive and misleading, instead of leading on to further truth. I can illustrate this highly important point by a few instances, that touch the relations, as well between different remains of animal life as between the conditions of particular animal remains and rocks, and between different rocks.

Some years ago, I found, in what seemed, superficially, the solid wall of a familiar chalk-pit, about thirty feet from the top, a horse's tooth. The naked fact was,—a horse's tooth found in the chalk. If I had been content to stop there, I might have announced indeed a grand discovery,—as everybody knows that such a fossil had never yet been found in such a place. But I knew that the fact which seemed thus naked, was extremely unlikely to be a real fact, being contrary to the Unity of Science, so far as this has yet been ascertained in regard to such a matter. So, instead of glorifying myself on the discovery of a horse in the chalk, I went to work to prove that it was not a true fact at all. And I succeeded. The chalk seemed solid enough; but, by careful examination, I became thoroughly satisfied that there had been a crack in the chalk bed, reaching up to the surface of the earth; and that this tooth—which I still show in my cabinet to warn the too eager discoverer—had, in the course of ages, got washed down through this crack, though the latter was imperceptible without close search;—and had so become lodged where I found it. This is an example of the relations between a fossil and the rock in which it is found.

Let me take another example,—and this shall be one of the relations between one form of animal life and another. All who are familiar with the chalk, know that different shapes of the oyster are very common in its beds. These vary much. On the varieties I cannot now enter. But no one has long worked the chalk without

meeting with specimens of the oyster wherein the outside of both shells is strongly stamped with a mark as if they had been sealed with some regular figure of the diaper fashion. You have the two shells. You think you have all that is needed ; and I have often been amused to see how collectors have been puzzled to make out what this mark can be. The explanation is, in fact, as plain as possible. There exists, in the chalk, a very remarkable group of fossils, called the *Ventriculidæ*, distinguished by a structure which was only discovered a few years ago, and the discovery of which showed that mathematical forms are not unknown in animal life, as had been before supposed.* Though these fossils are, as we find them, very delicate, it has been proved that, when living, their forms were not only durable, but particularly firm. Now, the oysters,—many of which were, in truth, but parasites,—were very fond of settling their young on these *Ventriculidæ*. Some of the oysters, after making a small fixed bottom of shell, throw up a rising wall ;—others creep, so to speak, with their shell along the surface of whatsoever it may be that they are first fixed to. Those of the latter that are fixed on the sides of the *Ventriculidæ*, fasten themselves with closeness to its shape, and follow all its indentations. The new shell is formed, in *both* valves, just beyond the edge of the animal within, so that both valves—which are then of the finest thinness—take the same impression. Though the animal afterwards grows, and layer after layer is added to the shell as the animal does thus grow,—so that the valves become thick, and the inner surface of each valve becomes quite smooth,—the outer surface of the shell bears for ever, on each valve, the stamp which was first thus got.

The last example shows that even an actual fossil often cannot be understood unless the nature of others be also understood. But it is no less certain that a mere mass of rock may itself be directly suggestive, and may open to the observer glimpses of something beyond what he yet knows ;—thus still teaching that each fact that can be found is related to facts beyond its mere self. Let me take one example to illustrate this. At the bottom of the London Clay you find what are called “Plumpudding Stones ;”—which are, indeed, amazingly like plum-puddings, with the small difference that they

* See “The *Ventriculidæ* of the Chalk ; their Microscopic structure, affinities, and classification,” etc., by Toulmin Smith. 1848.

would be very awkwardly trying to the teeth. Above these is the London Clay: below is the chalk. What story do these stones tell? They make it plain that, between the deposit of the chalk and of the London Clay, times and ages elapsed of which some account ought to be attempted to be given. Flints have been washed out of the solid chalk; and these have been rolled on some ancient shore till they have become discoloured and rounded. That shore has afterwards become a deep sea-bed; and these pebbles have become cemented together by a natural cement which is actually harder than the flint itself. Ages have passed on; and the rock thus formed has itself been upheaved, and broken into fragments; and these broken fragments have themselves formed the pebbles of some later shore, which had been rolling to and fro, and had done its work, and again sunk beneath the deep sea, before the oldest of the London Clay began to be deposited. Here, methinks, we see an outline Table of Contents of a wonderful time;—of which all the chapters are at present lost. Perhaps we may recover some of them. I give the illustration to show how much of a story a single pebble may carry within it, if looked at with reference to those relations which necessarily belong to it.

In using the microscope, every one knows how often it happens that the casual gazer declares himself unable to see what the careful investigator sees clearly before him. The reason is plain. The one comes all unprepared with any previous knowledge of the Relations of the things belonging to the class of object. The other looks at every object aided by the light of that impression of Unity which long and frequent previous study of related objects has made a living part of his active intelligence.

The Law of Unity,—namely, that everything we can find has its relations to something else, and is but one form of illustration of a wide-spread principle,—is the light by which every fact of Geology, as of natural science in every branch, must be studied. One man looks at a strange creature taken from the ocean, and sees in it a marvel, which is so wondrous that he makes out of it a supporter to the heraldic device of the nation that boasts herself Queen of the Seas. Another bethinks him, while he looks curiously at the same creature, that the Law of Unity does not deal in monsters, even to support the honour of the British name; and he sets to work,

with saw and chisel, at an equal distance on the other side the mid-line of the skull, and lo! he finds the fellow-tooth of that which, having enormously outgrown its fellow, men have wrongly called the Unicorn.

It is, then, a careful search after the RELATIONS of every fact, that alone can enable any fact to be safely asserted as a true one. Men had seen rocks and fossils long before the time of Lyell: but it may be said, with thorough truth, that it was Lyell's putting forth, and giving proof of, the proposition that the changes that are to be seen on the earth's surface are due to causes now in operation, that first made Geology a *Science*; and thus established one point of Unity which everything else has since clustered round and illustrated. And it seems to me that the very remarkable series of observations recorded by Mr. Rainey, of St. Thomas's Hospital, in his late work "On the mode of formation of shells of animals, of bone, and of several other structures, by a process of molecular coalescence demonstrable in certain artificially-formed products," heralds discoveries equal in importance, while similar in kind, to the great truth which Lyell first put forth. The reverent sense of admiration which contemplates Unity and design and order in all things, is a far nobler sense than that mere vacant Wonder which sees, indeed, a marvel, but understands it not, and is afraid to try to understand it. The mere looker at the solitary naked thing which he calls a fact, is but an Idiot by the side of him who knows that every individual thing he sees is the illustration of some far wider fact—some UNITY in nature, which makes it necessary for him to turn the illustration over and over in every possible shape, if he would hope to get at any true light, and to be anything other than a vacant wonderer or a hollow theorizer.

But I have detained you too long. Let me only add that, if this Association is to become a useful means in the progress of the science whence we take our name, it must be by its members putting, one and all, their shoulders to the wheel. Our very basis rests on the giving of a united effort for a common end. It is not any two or three of us that can carry the work out. For myself, unexpectedly asked to take this Chair, I have only consented to do so because I would not be backward to help in what I believe to be a good work; but I can only do it with the avowal that my engage-

ments,—far removed from following out a science which I love,—make it impossible for me to bestow on it the time I wish. So far as I am able, I will not be found wanting. There are many here far abler than I am to give the aid that is needed. Let me call on each to do what he is able towards collecting well-investigated facts; and to bring these before us, so that we may compare them, and, after a fair sifting, add them to the common stock of human knowledge. We shall thus accomplish a work, the value of which will soon become felt, and which will satisfy ourselves and those who are watching us—a few with jealousy, but most with hope—that “The Geologists’ Association” has not been formed in vain.

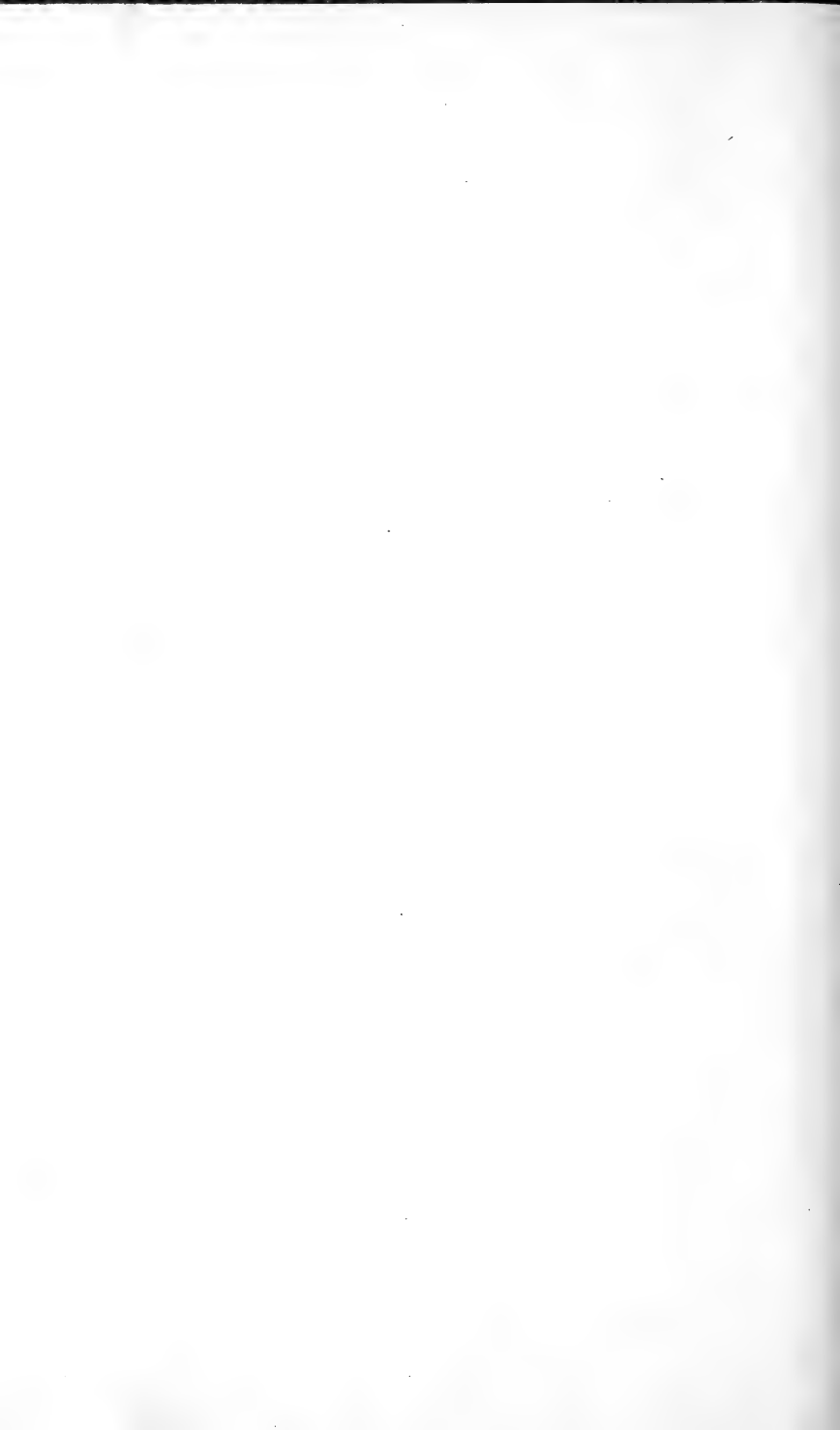
GEOLOGISTS' ASSOCIATION.

**"THE MINERALOGICAL DISTRIBUTION OF THE
BRITISH FLORA."**

(A PAPER READ ON JUNE 7TH, 1868.)

BY

REV. JAMES CROMBIE, M.A., F.G.S.



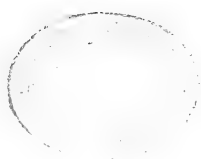
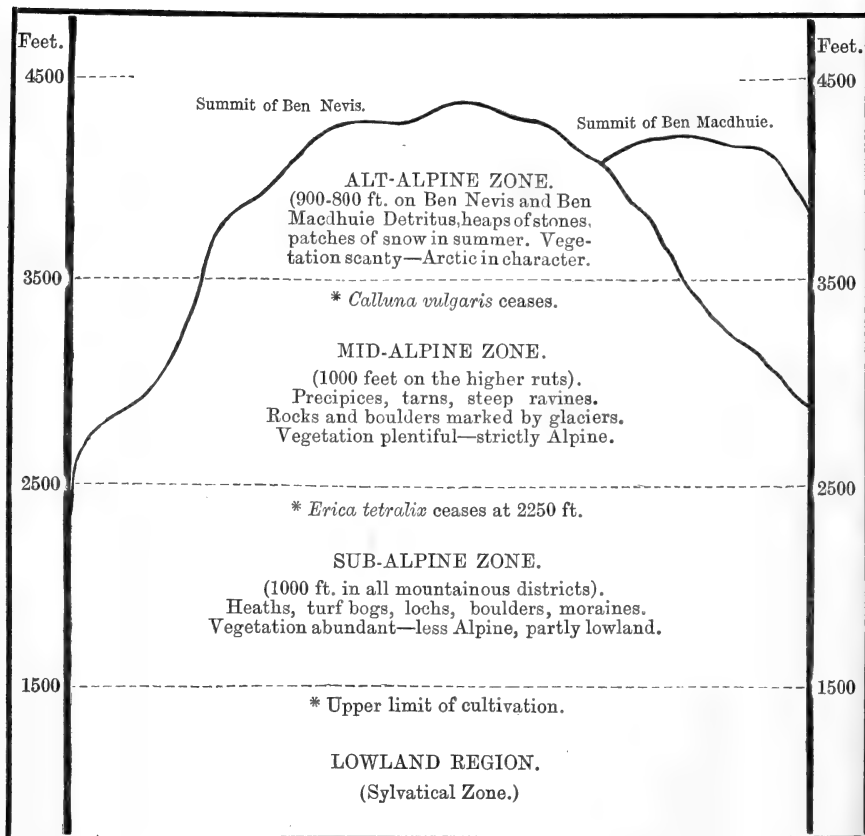


DIAGRAM OF THE ALPINE REGION,
AS REPRESENTED ON THE HIGHER MOUNTAINS OF SCOTLAND.



GEOLOGISTS' ASSOCIATION. /

THE
GEOLOGICAL RELATIONS
OF THE
ALPINE FLORA OF GREAT BRITAIN

BEING A PAPER READ BEFORE THE
GEOLOGISTS' ASSOCIATION OF LONDON.

BY THE
REV. JAMES M. CROMBIE, M.A., F.G.S.
X. reg

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THE GEOLOGICAL RELATIONS OF THE ALPINE FLORA OF GREAT BRITAIN.

The science of Botany occupies a very useful and important place in the study of the past state of our globe. Very considerable light it serves to throw upon many pages of the stony record, as it reveals under what relative conditions of light and heat, of land and water, the Flora, terrestrial and marine, of the primæval world, flourished and decayed. From the earliest remains of vegetation, met with in the lower fossiliferous strata, belonging to species now extinct, onwards to the more recent remains met with in our peat mosses and alluvial deposits, Botany, in its own sphere, plays as conspicuous, if not so extensive a part, as Zoology does in its sphere, in the contributions which it makes to Geological facts, and the assistance which it lends to Geological deductions. Fossil plants, as well as fossil bones and shells, tell from out their rocky bed to the Palæontologist, their own silent but eloquent tale of past and varied phenomena, leaving him to draw therefrom the conclusions to which the due exercise of his reasoning faculties necessarily leads him. It is not, however, with extinct or fossil plants, whether found in the earlier or more recent strata, that we are at present concerned, but with living species now existing within the limits of Great Britain, which occur in greater or less quantity at considerable altitudes upon our higher mountain ranges. These are generally known by the name of *Alpine*, in contra-distinction to *Lowland* plants, and belong to that type of our Flora which has been termed *Boreal*, from its being more

especially characteristic of the northern regions of Europe. But while it is with the present Alpine Flora of Britain that we are to be concerned, our purpose, in harmony with the object of this Association, is to show that this is intimately connected with, and directly derived from a past Geological condition of our island. It is indeed of but comparatively recent date that this condition has been generally recognised and rightly understood, though it is one in many respects most interesting and suggestive to the Geologist. Hence if to the purely Geological phenomena by which distinct intimations of it are given, we can add support from phytological sources, it will consequently derive so much extra and desirable confirmation. The subject may probably be novel to some of you, for, with few exceptions, it has scarcely received from Botanists or Geologists the attention which it so well deserves.

As already intimated, the Alpine Flora of Great Britain comprises such plants as grow only upon the higher mountain ranges of our island in Scotland, N. England, and Wales. It is, however, only in the first of these, more especially on the lofty and extensive group of the Grampians, that they occur in the greatest plenty and variety. The limits of altitudinal range, within which they are usually met with, are from some 1,500 feet, the upper limit of cultivation in Braemar, to 4,406 feet on Ben Nevis, the loftiest mountain in Britain. The space between these limits has been termed the *Alpine region*, which is sub-divided into certain *zones*, both physically and botanically distinct from each other. Commencing at the upper limit of the region, which in our country does not reach the snow-line, these are as follows : (1). The *alt-alpine* or gravelly zone, characterised chiefly by extensive tracts of detritus, scattered heaps of broken boulders, and large patches of snow in summer, extending downwards to about 3,500 feet, and which is fully represented only on some of the more elevated of the Grampians. As might be expected from

its altitude, it is characterised by a rather arctic form of vegetation, though it contains only a very few plants which do not descend into the other zones. (2). The *mid-alpine* or rocky zone, characterised chiefly by wide corries, steep precipices, deep tarns and rapid streams, stretching from the preceding to about 2,500 feet, and which is more or less fully represented on all our higher mountain ranges. Its vegetation, unlike that of the preceding, is both varied and abundant, consisting chiefly of the rarer and more prevailing species which constitute our Alpine Flora. (3). The *sub-alpine* or heathy zone, characterised chiefly by dry moors, peaty soil, wet marshes, and dark lochs, reaching to the lower limit of this region, and better represented than either of the others, in all our mountain ranges. It contains a flora which is partly its own and partly derived from the upper and the lower tracts, in the alpine and the lowland regions. But here it is of importance to observe that this zonal distribution is applicable not only to our phænogamies, to which it is usually limited, but also to our cryptogamies, to which it has very seldom, if ever, been applied. And this, probably, for the reason that at first sight the majority of the cryptogamies seem to be much less affected by such divisions of elevation, though a closer and more minute inspection sufficiently demonstrates that either in kind, in number, or condition, they are in reality thus influenced to a very considerable, if not equal degree. The Alpine floral region, then, consists of plants which are found only between the above-mentioned limits of vertical range in Great Britain. Some of them, however, under special circumstances, such as growing in the northern maritime tracts, and on more isolated and exposed peaks, or in consequence of being washed down by the streams, not unfrequently occur at much lower altitudes. Our native Alpine phænogamies constitute about 1-15th of our whole flora; while the cryptogamies, with the exception of the fungi and algæ, form a still larger proportion of the British species.

But in order to make the physical and phytological character of this Alpine region more intelligible to you, and to enable you to understand more easily our subsequent remarks upon the Geological relations of its flora, let me carry you in imagination to the summit of one of our loftiest mountains, and point out as we descend what is most noteworthy in its natural features and vegetation. For this purpose I shall not choose Ben Nevis, which, as already stated, is the loftiest mountain of our island, but one which in several respects is better adapted to illustrate what I have in view, viz.—Ben-na Macdhuì, the second highest, which attains an elevation of 4,296 feet, according to the Ordnance Survey. This constitutes one of a series of very lofty mountains in the northern Grampians of Scotland, in the district of Braemar, and is surrounded, amongst many lower hills, by about a dozen neighbours, but slightly inferior in elevation to itself. In the same district, also, there are numerous other mountains, attaining an altitude of not less than 3,000 feet; so that we have here the most elevated ground of similar extent in Great Britain. Transported to the summit of this mountain, which is entirely composed of reddish granite, varied only by veins of quartz, and commencing our inspection from the highest point, which is marked by a large cairn of stones, we make the following observations. The summit, about three miles in circuit, is broad and rounded, gradually sloping down on all sides into deep glens and corries, except on the N.W. and S.E., where it is coterminous with two other lofty mountains. In one part it is covered with masses of broken granite and quartz, generally of considerable size, interspersed here and there with larger boulders, and having the appearance of being more or less water-worn, which are evidently fragments of rock that once stood *in situ*, as may still be seen on some of the neighbouring mountains, where, at a distance, they appear like large protuberances upon their bare brows. In another part, again, we perceive extensive tracts of coarse detri-

tus, often of great depth, resulting from the disintegration of these fragments by glacial action and atmospheric influences, the latter of which, at this elevation, possess a strength and power unknown in lower tracts. Amongst these stones and this detritus large patches of unmelted snow in the hollows greet the eye, even in the warmest summers, from the lower margin of which there usually issue forth the cold waters of springs and rills. Upon the whole summit but a very scanty vegetation is seen, consisting chiefly of mosses and sedges, though all the different classes of our flora have their representatives. With the names of these I need not at present trouble you, but shall simply state that of phænogamic plants there occur only some seven species, the test plant of this alt-alpine zone being *luzula arcuata*, which descends only some 700 feet. The cryptogamics, however, are more plentiful and varied, the test plants of this zone in the different families being *lycopodium selago f. minor* for the Filicineæ, *andreæa nivalis* for the Musci, *iungermannia orcadensis* for the Hepaticæ, *lecidea arctica* for the Lichens, *protococcus nivalis* for the Algæ, and *agaricus nivalis* for the Fungi. All the alt-alpine plants bear a strong resemblance to those of more northern latitudes in their social and stunted manner of growth, in the relative proportion of phænogamics to cryptogamics, as also of the different tribes of these to one another. But leaving this zone, we arrive, after a gradual descent of about 850 feet from the summit, at the mid-alpine zone, which presents very distinct and well-marked features from the one above. Like the preceding, it is very well and completely defined on Ben-na Machdui on every side, save the two already mentioned. It consists chiefly of lofty and nearly perpendicular precipices, sometimes 1,500 feet in height, usually of a more or less semicircular form, so as to constitute, as it were, a large deep hollow in the sides of the mountain, whence the Gaelic name *corrie*, literally a caldron, applied to such places. The rocks of these precipices are occasionally solid and

smooth, but generally rifted and broken, so as to present numerous ledges with slopes of detritus at their base, patches of snow lying in their crevices, and rapid streams rushing headlong down their ravines. Fed by these and the melting snows, a deep mountain tarn, or small lake, is seen in the lowest part of the corrie, of which there are several on this mountain, whose waters seem either black as ink in spots averted from the sun, or of the deepest blue, sometimes green on their gravelly margins, where exposed to its rage. Both rocks and lochs bear evident traces of glacial action at different epochs, seen in the former in their grooved, scratched, striated, and polished surfaces, and in the latter, more especially the larger ones, in the manner in which they have, to some extent at least, been scooped out in their rocky beds—phenomena, however, which are still more apparent on some of the other mountains of this district. The vegetation of this zone throughout is in every respect much more varied than that of the higher one. In addition to the general covering which, except on the naked precipices, it almost everywhere presents, of such very social plants as grasses, carices, and short ling, as also numerous mosses and lichens, the sides of the streams, the margins of the tarns, and more especially the ledges of the precipices, are characterised by the presence of those alpine plants, amounting throughout Great Britain, in all the classes, to probably some 400 species, which gladden alike the eye and heart of the phænogamic and cryptogamic botanist in their mountain rambles. On leaving these corries, with their grand and desolate scenery, we begin to enter the sub-alpine zone. This generally commences with a somewhat flattish table-land of but limited breadth, from which we descend into narrow lateral glens which after a time open out into the main valleys, which, confined and steep at first, gradually become wider and less elevated, till at length the Alpine merges into the Lowland region. Over the whole of this tract, which presents, here and there, expanses of

dry moorland or wet marshy ground, covered with heath, sedges, and sphagna, huge boulders lie scattered in great profusion on the slopes, by the streams and lakes, which either have been rent from the precipices by the snows and torrents of winter, or have been conveyed by former glaciers to the lower grounds in the valleys. And probably a still more characteristic feature of it is the *moraines* of all sizes which occur towards the mouths of these lateral glens, as mementoes of the existence of the olden glaciers, and which are very numerous and striking in the glens of the Garrachory and Guisachan on the west side of the mountain. The vegetation of this zone is characterised chiefly by the abundance of the more social flowering and flowerless plants, being otherwise of a rather composite nature, consisting as already stated of a flora partly peculiar to itself, and partly derived from the upper and lower tracts. And, indeed, many lowland plants, familiar to us all, ascend even into the mid-alpine zone, in more sheltered spots, and mingle themselves with their alpine sisters, stretching from the sea shore to the mountain corries, from the margin of the German Ocean to the lochans of Ben Macdhui.

Now these general observations upon the vegetation of one of the loftier mountains of Great Britain, in connection with its physical characteristics, are, after making due allowance for diversity of situation and consequent exposure, of height and consequent temperature, of mineralogical structure and consequent natural features, equally applicable to those of the rest of the Scottish Highlands, as also of north England and Wales. The alpine plants, especially of the two latter, are certainly more restricted in number, and some plants are found in the one region which are wanting in the others, but this is just what constantly happens on any two or three mountains standing in immediate propinquity to each other in the same tract. Hence, were you thoroughly to have explored all these alpine regions, and

collected their botanical treasures, phænogamic and cryptogamic, you would perceive that the flora of each was so similar in its main features, as clearly to betray a common origin and similar mode of distribution. What then was this origin, and when did it take place, in what manner was this dissemination over distinct mountain ranges effected, are the two correlative problems which we have to solve. And in arriving at a correct solution, it will materially assist us to compare our boreal flora with that of other northern countries. Suppose you had made a complete collection of British Alpine plants and written out a catalogue of their names. On comparing this with a like catalogue of those of other alpine regions, you would find that there was a greater similarity between it and that of Scandinavia than of any other country on the globe. In fact, but for the circumstance that the Scandinavian list possesses a greater number of species belonging to a strictly Arctic type, not found in Britain, as might be expected, the two would be quite identical. Whence then this similarity in the floras of two countries, far separated from each other by the waters of the German Ocean? Is it that plants were originally distributed by haphazard over the world, and that they grow indiscriminately wherever there is a soil and climate suitable for their different natures? The whole experience of Botanical Geographers is against such a crude supposition, which has long ago been sufficiently exploded. We must, therefore, account for it in some other way, and on some more scientific principles.

The key to the solution of the problem is undoubtedly to be found in the now almost universally recognised doctrine of "Specific Centres," that is, of certain geographical points from which different types of plants have radiated. Such a doctrine, apart from any other considerations whatever, seems to be necessitated by the fact to which Mons. De Candolle alludes in his essay on Botanical Geography, though he does not carry out

the result to its legitimate issue. "It might not, perhaps," he observes, "be difficult to find two points in the United States and in Europe, or in equinoctial America and Africa, which present all the same circumstances; as, for example, the same temperature, the same height above the sea, a similar soil, an equal amount of humidity. Yet nearly all, perhaps all the plants, in these two similar localities shall be specifically distinct." The same might with equal propriety be said, in a more restricted sense, of the alpine flora of our own and other countries, but not to go beyond our own islands it meets with ample corroboration within themselves. Two places might be found on the mountains of S.W. Ireland and Wales, possessing the same specified conditions, and yet we find that their characteristic alpine flora is totally distinct, the former being allied to that of the West Pyrenees, and the latter, as we have said, to that of Scandinavia. All such difficulties, otherwise insuperable, in understanding the distribution of our Alpine or other floras, are readily explained by the theory which the late Professor Edward Forbes promulgated and illustrated in his essay on this subject appended to the Memoirs of the Geological Survey of Great Britain. In this, he regards our phænogamic vegetation as made up of five separate floras,* each of which is intimately related to some distinct continental flora. But it will at once be evident that before our phænogamic, and let me add also, our cryptogamic vegetation could have been disseminated from these continental centres, a relation very different indeed from the present, must at one time have subsisted between them and our islands. Accordingly Forbes considered the different floras constituting his five types, as outposts, separated by certain Geological changes, such as the rising, subsidence, and dislocation of land, from more extended areas. On this theory, the British Isles were at a former period or periods united in

* See Appendix.

some way or other to the countries whence the different types were derived by transmission either over continuous or contiguous land, or where such did not exist, by other adequate means of diffusion.

Let us then very generally, for we need not, even did time permit, enter into minute details, apply this theory to the origin and distribution of our alpine flora, and see what grounds there are for its adoption in this particular instance. Now assuming, as we are sufficiently warranted in doing from their similarity, that the boreal flora of Great Britain had its origin from that of Scandinavia, the specific centre whence it was derived, by what means was it conveyed across the wide expanse of intervening sea to its present habitat? This, it is evident, could have been effected only at a period when there was some connection of one kind or other between the mountains of Scandinavia and those of Britain.

We have no grounds for inferring that the two regions were ever at any time connected by continuous land or a mountain barrier, as was the case between other portions of our islands and continental countries. True there can be no question that the East Coast of Scotland once extended farther into the sea than now, as evidenced amongst other things by the remains of peat mosses buried beneath the waters and covered by the sands; and there can be little doubt that the Scandinavian coast was also at one period extended farther westward, of which the numerous islands on the W. of Norway are the mementoes. But they never seem, at all events, in any suitable epoch, to have been intimately connected by dry unbroken land, across which the flora might have been transported. Nor even had they been so, would this sufficiently account for the similarity of the plants of the Scottish mountains and those of N. England and Wales. For between these three also it is very evident that a connection different from the present must have existed before they could have

migrated from the one to the other; since they could no more have been transmitted across the intervening lowlands, except by some special agency, than they could have been transmitted, except in the same way, across the waters of the German Ocean from Norway to Scotland. Hence Forbes supposed that the distribution of this alpine flora was effected during the glacial epoch, which, indeed, the very character of the plants themselves point out as the most suitable. During this period, as substantiated by various geological and physical phenomena, to some of which we have referred in our sketch of Ben Macdhuì, the mountains of Great Britain stood forth as hilly islands in the case of the Grampians and the other higher peaks, or as low-lying islands in the case of the other and inferior groups, whose rocky coasts were swept by an arctic sea and grinded by its icy waters. In all probability, these were but members of a chain of islands, vestiges of which are still preserved in those of Orkney and Shetland, extending to the area of Norway through a glacial ocean, and clothed with a boreal vegetation, which subsequently, as the islands were gradually upheaved and the climate consequently changed, became limited to the upper portions of the new-formed and still existing mountains. This interesting theory thus carries us back for the origin and early diffusion of our alpine plants, to an epoch now well known to and universally recognised by geologists, when the climatal conditions of the area under notice were such as to be admirably adapted for the diffusion of a sub-arctic flora, destined to become afterwards an alpine one, from its home in the parent north. Upon the numerous and varied proofs for the former and protracted existence of such an icy sea extending over the whole of Northern Europe, and southward even to the Alps and Carpathians, I need not at present enter, as these are quite familiar to you all. For the elucidation of our theory, all that is absolutely required is simply to conceive of it as presenting somewhat similar physical

phenomena to those still displayed in the arctic regions, bounded in one part by snowy hills, and studded in another with ice-girt islands. Once these the flora of the area in question would easily be transported, by natural agencies, from what are now the mountain ranges of Scandinavia, to those outposts on the mountains of Great Britain which they at present occupy. Conveyed in this way from island to island, borne on the bosoms of floating icebergs, the wings of stormy winds, and by wandering arctic sea-birds, they would first reach the higher islands which the Grampians then constituted, and where they still grow in greater plenty and variety, with a more decidedly arctic character than elsewhere in the kingdom. Thence carried in a similar manner, they would subsequently reach the lower islands of Scotland, N. England, and Wales, now elevated into mountainous regions. It would, however, for the most part, be only such plants as grew upon the shores or lower slopes of the insular Grampians that would thus be transported to those other and lower islands, and find congenial habitats at a similar altitude to their native one. Accordingly we find that the alpine flora of these, except upon the very summits of the loftier peaks and ridges, is chiefly of a much less arctic character than that of the Grampian range. This cannot be adequately explained by difference in temperature and elevation, for on many of the lower and more exposed peaks of the Grampians we find some plants which grow only at much higher elevations upon their neighbours. Such a phenomenon evidently depends on the circumstance that in the one case, the means of their dissemination were close at hand, and in the other more remote or entirely absent. In this way the presence of identical species at such distant points, which otherwise could not be satisfactorily accounted for, is readily explained, and their original derivation and present diffusion are no longer enveloped in mystery.

The theory, therefore, which we have thus briefly stated and

illustrated, supplies us with a sufficient and intelligible cause, both for the general distribution of this boreal flora throughout our island, and also, to some extent, for its more special distribution amongst our different mountain regions. No other theory which has yet been propounded upon the subject is so probable in itself, or recommended by such valid reasons; while everything that we know of the phenomena of this geological epoch, and the peculiarities of this phytological distribution, serve but to give even additional confirmation to what it possessed in the days of Forbes. Nor does it in any way invalidate its strong claims to our acceptance to find that some species, not natives of the Scandinavian Mountains but of the Alps, are found sparingly in one or two localities in the British ranges. For it was only to be expected that these should, in return for species received from the icy north, give back to our latitudes some few of their own on the retirement of the glacial ocean. And the only other consideration which at first sight seems to militate against it, is capable of an easy and satisfactory explanation. This is the fact of numerous lowland plants being present amongst these alpine ones, and in some few cases attaining an almost equal elevation. These, however, are not contemporaneous with their sub-arctic sisters, but belong to a later geological epoch. They were introduced after the glacial sea had disappeared, and the uplands and lowlands emerged from its bosom, after the islands had been elevated into mountains and connected together by dry land, after the climate had become greatly changed, though the glaciers still lingered in the higher corries, when Britain was joined to Germany and Ireland to Britain, and everything was suitable for another type of vegetation from a more southerly clime, obtaining a firm footing in the country, and gradually, in the course of long ages, as the temperature and natural features of the country became as they now are, spreading itself from the lowlands to the uplands, and

thence more sparingly into the alpine region. In this, their distribution, like that of the boreal plants themselves, is regulated by temperature, nature of soil, degree of exposure, and such like, which exercise separately, and in combination, a very marked influence thereon. For though not sufficient to account for the existence of either of these types in their respective areas (else why should the flora of the mountainous tracts of the south-west of Ireland be of such an opposite character to that of Wales, and the latter agree so closely with that of the Scottish Highlands?), yet, but for such influences, there seems no reason why our lowland plants should not ascend to the summit of the mountains, and our alpine plants descend to the plains.

Such, then, is a general view of the geological relations of our alpine flora—a subject, it may be, novel to some of you, but on that account only all the more interesting. If the theory which we have thus briefly stated, without entering into minute details, be correct, and I do not see what valid objections can be taken to it, then to the names of alpine, boreal, and highland, by which this type of plants has been denoted, we may with great propriety add another, and call it the *Glacial* Flora of Great Britain. And whether you accept the theory or not, it at least has served the purpose of turning your thoughts this fine summer evening from the old petrified bones and shells hid in the bosom of mother earth, to the robe of living verdure, she is now up on the mountains, by alpine rock, and stream, and tarn, so joyously wearing. And yet the latter speaks to us geologists as eloquently and instructively, it may be, as the former, and tells us how, in a phyto-geological point of view, the past and the present conditions of our island are closely connected together.

APPENDIX.

The five separate floras which Forbes, in the essay referred to, regarded as making up our phænogamic vegetation are as follows :—

1. An *Asturian* flora, confined to the mountainous districts of the south and west of Ireland, connected by the presence of certain prevalent species with that of the mountains of Asturias, in Spain. From these latter it was evidently derived through migration over a great mountain barrier, which once extended from the West Pyrenees to Ireland. Its southern alpine character, so distinct from that of the mountains of Wales and Scotland, its limitation and isolation, are so many evidences of its antiquity, and serve to mark it out as the oldest of the floras now comprising our vegetation. 2. An *American* Flora, in the S.W. of England and S.E. of Ireland, intimately related to that of the Channel Islands, and the opposite coast of France in Brittany and Normandy. Its distribution depended on the subsequent existence of a barrier from the N.W. of France to the S.W. of England, and thence to Ireland, across which it was conveyed. This is in all probability the second oldest flora, and its separation from the parent centre, seems to have resulted from the destruction of the Atlantic barrier, having led to the destruction of this one also, though remains of it still exist in the various islands of the channel. 3. A *Belgic* Flora in the S.E. of England, where the cretaceous system of rocks is chiefly developed, in which many species occur which are common to this and the opposite districts of France. It was afterwards introduced at a period when the N.E. coast of France and the S.E. coast of England were united, and formed portions of the same area, though it has since partially extended itself into other formations than the cretaceous. 4. A *Boreal* Flora, found principally on the higher mountains of Scotland, and partially on those of N. England and Wales, which is closely allied

to the Alpine Flora of Scandinavia. As we have seen, this depends for its derivation upon other causes than any barrier connection between Norway and Britain, and is evidently to be referred to the glacial epoch, when the mountains of Scotland, N. England, and Wales, were hilly or low-lying islands in an icy sea, connected by other groups now submerged, with Norway, whence the plants now found towards their summits were transported. 5. A *Germanic* Flora, forming the general vegetation of the British Isles, which is identical with that of Central and Western Europe, giving a general character to the vegetation of these countries, as well as to that of our own. Its introduction was effected on the upheaval of the bed of the glacial ocean, and the consequent connection of England with Germany on the one hand, and with Ireland on the other by means of extensive plains, the fragments of which still exist. Over these the plants of which it is composed, and which form our most recent indigenous flora, were transmitted, in all probability, as we believe, at three different climatal periods, adapted respectively for the introduction in such order of the *Scottish* or more northern, the *British* or general, and the *English* or more southern types of this flora.

As to the geological epochs at which these different floras were introduced, we may consider them as commencing towards the end of the Eocene period, with the Asturian, which is, probably, but a fragment of the vegetation of the true Atlantic, and extending to the post-tertiary period, when the present aspect of things was organized and the Germanic type found a firm footing in the country. Hence we may take it for granted that all our indigenous flowering plants found a home in Great Britain and Ireland, before the formation of the Straits of Dover, and of the Irish Sea, as now existing. With a greater or less expanse of water then surrounding them on every side, and effectually separating them from the neighbouring lands,

there was no further opportunity afforded for the diffusion by *natural* means of any other floral type, or of any other new species of plants from these into our islands. And here, could we possibly determine with accuracy what plants were thus and then introduced, we would have the only adequate solution of the much *vexata questio* amongst botanists, as to what really constitute our *native* versus our *naturalised* species. The theory thus briefly stated, and illustrated at some length in the case of our alpine flora, will, as we have said, be found to hold good also with respect to our cryptogammic flora, which Forbes does not notice. From the uncertainty, however, as to the distribution of some orders of these, such as the fungi, we have, as yet, been able fully to work it out only in the mosses and lichens. Moreover it is applicable, as may readily be inferred, not only to the flora of our own, but to that of any other country, and the more we have examined the grounds upon which it rests, and the proofs by which it may be supported, the stronger these have been felt to be and the better its claims to our acceptance. Starting, with the geological relations of plants as enunciated in this theory, the geographical botanist is in a much better position to estimate the various influences exerted by climate, habitat, soil, and such like, in regulating their subsequent distribution over the several countries of the globe.



GEOLOGISTS' ASSOCIATION.

(PAPER READ 1st JANUARY, 1869.)

“MAN AND THE MAMMOTH.”

BY

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PROCEEDINGS
OF THE
GEOLOGISTS' ASSOCIATION.

Paper Read 1st January, 1869.

“Man and the Mammoth: being an Account of the Animals found Associated with Early Man in Pre-historic Times.” By Henry Woodward, F.G.S., F.Z.S., of the British Museum.

HAVING a short time since drawn up a brief statement of the evidences upon which the presumed antiquity of the human race in Western Europe is based, and also some account of the animals found associated with early man in this region, I have ventured to think it may be found of sufficient interest to lay before this Society.

It is based only in a very small part upon my own observations, being chiefly composed of materials gathered from the published labours of my friends and colleagues, who have specially devoted their time and energies to these researches.

The question of primeval man and his contemporaries is now, by common consent, admitted to be one of the most important geological topics which has occupied the attention, not only of men of science, but also of the educated classes generally, in the present day, and notwithstanding the works already published, it may be said that the public mind is still craving for fuller information.

Nor need that craving remain altogether unrelieved, for every month contributes its quota to the general store of published facts and discoveries, and we may ourselves add thereto by careful obser-

vations in our own district if we only know how, when, and where to observe for ourselves.

The class of deposits which have yielded the evidence of which I am about to speak, cannot be said to have been altogether previously unnoticed, but it is only during the past ten years that the painstaking, careful investigations of such men as Prestwich, Falconer, Lubbock, Lartet, Christy, Pengelly, Evans, Boyd-Dawkins, Sanford, Dupont, and others of the same high stamp, have resulted in the real discoveries and vast additions to our knowledge of this last chapter of geological history heretofore unwritten, and in which Man and the Mammoth take part.

Let us for a moment retrace the course of these events. So long ago as 1823, that distinguished British geologist, Dr. Buckland, published his celebrated work, the "*Reliquiæ Diluvianæ*," in which he described the organic remains contained in ossiferous caverns and fissures, and "diluvial gravel" in various parts of Europe. But the Dean, although so acute a geologist, concluded that none of the stone implements or human remains met with in these deposits could be considered to be as old as the Mammoth and other extinct and foreign animals, with the bones and teeth of which they were associated.

So little was the study of Geology then understood, that the idea of any remains of man being found in deposits older than those attributed to the Noachian deluge was rejected as contrary to Scripture, and generally received opinion.

At this early period, however, 1824, the late Rev. Dr. John Fleming, F.R.S.E., at that time a minister in the Scotch Presbyterian Church, (afterwards Professor of Natural Philosophy in Aberdeen, and latterly Professor of Natural History at New College, Edinburgh,) contributed an article to the "Edinburgh Philosophical Journal," vol. xi., 1824, "On the Influence of Society on the Distribution of British Animals," in which he ably argued against the views of Dr. Buckland, and showed (even from the then comparatively scanty evidences) that there was incontestible proof of the contemporaneity of the human and animal relics found associated together in these cave-deposits, and that they were clearly the remains of the former denizens of the same region, entombed in

their present burial places by similar causes to those now in action, and not by any wide-sweeping catastrophe, such as was assumed by the advocates of a universal deluge.

There was (1824-5) a highly intelligent Roman Catholic Priest living at Torquay, the Rev. J. McEnery, who, having examined a certain cavern, known as "Kent's Hole," discovered flint implements of undoubted human workmanship associated with bones of the Mammoth, the tichorhine Rhinoceros, cave-bear, and other mammalia, about the contemporaneity of which he does not seem to have doubted, and the correctness of his views have been now well-established by subsequent investigation.

The next (1833-4) earliest systematic work of exploration we find was carried out in the valley of the Meuse, Belgium, by the late Dr. Schmerling, of Liége, who carefully searched for and exhumed the fossil human and animal remains buried together in the ossiferous caverns around Liége, an account of forty of which he published, with figures and descriptions of their buried contents.

In 1841 M. Boucher de Perthes commenced to collect, and, in 1847, to publish the result of his researches in the gravel-deposits of the valley of the Somme, around Abbeville, and the sight of his collection of flint-implements induced Dr. Rigollot to search the gravel-pits around Amiens, which also yielded singular proofs of prehistoric man. Notwithstanding the publication of these discoveries, however, public interest was not as yet aroused, and the French savans of Paris only laughed at Monsieur de Perthes and his researches.

Meanwhile English geologists were accumulating facts and material, which only needed some fresh motive force to give it vitality and importance, and it came at last after long years of waiting.

To the late Dr. Hugh Falconer, F.R.S., we no doubt owe the initiation of a new era in the investigation of ossiferous deposits. For, although Mr. Trimmer, Mr. Godwin-Austen, Mr. Prestwich, and many other good geologists were at work long before this period, it was the systematic exploration of the Brixham cave, near Torquay (commenced in 1858), which first excited public attention to this interesting branch of geological inquiry, and set in motion similar explorations in France, Spain, Belgium, Italy, Malta, and elsewhere.

Added to this, we became aware of those remarkable discoveries made by Prof. Keller and others of ancient Lake-habitations in Switzerland, somewhat resembling the Crannoges of the Irish Lakes (now mostly buried in peat-bogs, which have filled up these ancient fresh waters).

At the same time, our countryman, Mr. Henry Christy (then fresh from his Mexican travels), brought home to us not only the contents of the French caves, but also those of the Danish peat-mosses and refuse-heaps, thus adding new interest to the investigation of pre-historic man.

Nor have these varied materials been allowed to remain as idle curiosities in our Museums, to be objects of marvel or conjecture; on the contrary, they have been subjected to the most severe investigation by the best and ablest among our archæologists and geologists, and, like the vision described by the prophet Ezekiel (xxxvii.), we have seen the dry and mouldering remains of these ancient inhabitants of our island arise; we have seen the animals they followed in the chase, the weapons which they used, the ornaments they wore, and have even learned a good deal concerning the rude arts they practised. Nor is this all we have gained, for we can now compare each fresh discovery with such a series of recorded precedents, spread over such wide areas of explored country, that we can refer each find to one or other of a series of stages representing periods in the history of these ancient races, which, although not reducible to years, or even centuries, yet are capable of being dealt with in chronological sequence, just as the earlier deposits have been arranged by geologists long since.

The evidences of the remote antiquity of man are derived from various sources :—

1. The ancient quaternary river-gravel deposits.
 2. The ossiferous caverns and rock shelters.
 3. The shell-mounds or refuse heaps of Denmark, the Orkneys, the Welsh coast, etc., etc.
 4. The Danish peat-mosses.
 5. The Irish lakes and peat-bogs (crannoges).
 6. The Swiss pile-works, or *Pfahlbauten*.
1. The first of these is, undoubtedly, of the most ancient character ;

but is also (as might naturally be expected) of the most meagre and restricted kind, chiefly consisting of flint implements of rude and simple form, and with but little variety of pattern. No authentic instance of human remains associated with these flint weapons is recorded; but, after the most careful investigation of these deposits by Messrs. Prestwich, Evans, Falconer, and a number of other undoubted authorities, whose judgment may well be relied upon, the following conclusions were arrived at:—1st. That the flint implements are the result of design, and the work of man. 2ndly. That they are found in beds of gravel, sand, and clay, which have never been artificially disturbed. 3rdly. That they occur associated with the remains of land, freshwater, and marine testacea, of species now living, and most of them still common in the same neighbourhood, and also with the remains of various mammalia, a few of the species now living, but more of extinct forms. 4thly. That the period at which their entombment took place was *subsequent* to the Boulder-clay period, and to that extent Post-glacial; and also that it was among the latest in geological time—one apparently immediately anterior to the surface assuming its present form, so far as it regards some of the minor features.¹

It is hardly needful to point out to you the regions included in this first division. The valley of the Waveney at Hoxne, Suffolk, where flint implements were found in the year 1800 by Mr. Frere. (*Archæologia* for 1800, vol. xiii., p. 206.) The Ouse at Bedford, where Mr. Jas. Wyatt has found flint implements and remains of Elephant, Rhinoceros, Hippopotamus, etc. The Thames-valley high level gravel, where, in an excavation in Gray's Inn-lane, London, a flint weapon associated with the skeleton of an Elephant, was found so long ago as 1715; at Fisherton, near Salisbury; in the Trent, not far from Nottingham; in the Vale of Pickering, the Somme, the Seine, the Rhine, the Val' d' Arno, and many other localities.

2. The ossiferous caverns and rock-shelters have long been known, but not systematically explored until ten years since. Their contents, as might have been expected, are more rich and varied, and they have given us a greater insight into the state of civilization of their ancient

¹ Falconer, *Palæontological Memoirs*, 1868. Vol. II. p. 598.

occupants than almost any other. The British localities are in Devon and Somerset, near Torquay and Brixham, and in the Mendip Hills; the promontory of Gower in South Wales, where eight caves have been carefully explored by Colonel Wood and the late Dr. Falconer; the Coygan Cave, near Laugharne, Carmarthenshire, partially explored by Mr. Henry Hicks, of St. David's. (See *GEOL. MAG.*, vol. IV., page 307, 1867.) The historical cave of Kirkdale, rendered famous by Dr. Buckland's researches. The Caves of Liege and of the Valley of the Lesse in Belgium; of the Vezere, the Dordogne, and the Aveyron in France, explored by Schmerling, Dupont, Lartet and Christy, the Vicomte de Lastic, the Comte de Vibray, and many others. Rich as is the fauna revealed by our English Caves, they cannot be compared for one instant as regards the human remains and works of art which the French Caves have made known to us, I say, advisedly, *works of art*, for we have now ample materials in this country even to show the wonderful ingenuity and skill displayed by the ancient Aquitanians in the fabrication of needles, weapons of the chase, both in wood and stone, swords made of reindeer horn, ornaments in the same material; and, lastly, in depicting the animals they knew living around them.¹

The time forbids me to enter upon an account of the Shell-mounds and Danish Peat Mosses; nor of the Irish Peat-bogs and Swiss Pile-works, each of which would form a chapter by itself. On the contrary, I shall, by your permission, occupy your attention with a brief account of the fauna of the Pre-historic period generally, as revealed to us in the various superficial deposits included in what is now generally termed the Quaternary epoch.

In the accompanying Table I have endeavoured to show the species of animals found in association with early man, as evidenced by his weapons in one set of deposits, and by his osseous remains

¹ Those interested in these researches, who have not yet personally inspected the rich collection of Pre-historic remains, so admirably arranged and displayed in the Ethnological department of the British Museum, and the Christy Collection (exhibited on Fridays,—admission by ticket, obtainable gratis any day at the British Museum), under the able direction of A. W. Franks, Esq., F.R.S., F.S.A., F.G.S.,—should take the first occasion to do so, and they will find themselves well repaid by seeing probably the best collection extant of works of early and savage man from all countries.

and handiwork in another. I have also introduced certain other species (those whose names are enclosed in square brackets) whose remains are not found with man, but in a somewhat older set of deposits, containing, however, some of the animals common to the Pre-historic epoch. Those names of species *not enclosed in square brackets*, are again divisible into—I. Animals known to man, but now extinct. II. Animals whose geographical distribution has been changed. III. Animals which have been exterminated by man; and, IV. Animals still indigenous to Britain and the neighbouring continent.

TABLE OF ANIMALS CHARACTERISTIC OF THE PLIOCENE AND QUATERNARY DEPOSITS OF BRITAIN, FRANCE, AND BELGIUM.

<i>Castor Europæus</i> , Owen.....	...	...	K		<i>Ovis aries</i> , Linn.....	...	...	...	L
„ [<i>Trogontherium</i> , Fischer]	X				<i>Cervus elaphus</i> , Linn.....	...	...	...	L
<i>Mus musculus</i> , Owen.....	...	...	L		„ <i>capreolus</i> , Linn.....	...	...	...	L
<i>Arvicola amphibia</i> , Owen.....	...	...	L		„ <i>tarandus</i> , Linn.....	...	M		
„ <i>agrestis</i> , Fleming.....	...	...	L		„ [<i>Sedgwickii</i> , Gunn]	X			
„ <i>pratensis</i> , Owen.....	...	...	L		„ [<i>Brownii</i> , Dawk.].	X			
<i>Spermophilus citillus</i> , Linn.....	...	M			„ <i>dama</i> , Linn.....	...	...	...	L
„ <i>erythrogenoides</i> , Falc.	X				<i>Alces malechis</i> , Linn.....	...	M		
<i>Lagomys spelæus</i> , Owen.....	X				<i>Megaceros hibernicus</i> , Owen	X			
<i>Lepus timidus</i> , Linn.....	...	...	L		<i>Machairodus latidens</i> , Owen	X			
„ <i>cuniculus</i> , Linn.....	...	...	L		<i>Felis spelæa</i> , Goldf.....	X	M ²		
<i>Lemmus lemmus</i> , Linn.....	...	M			„ <i>antiqua</i> (?).....	X			
<i>Elephas primigenius</i> , Blum.....	X				„ <i>catus</i> , Owen.....	...	...	...	L
„ <i>antiquus</i> , Falconer.....	X				<i>Hyæna spelæa</i> , Goldf.....	X	M ³		
„ [<i>meridionalis</i> , Nesti.].....	X				<i>Canis lupus</i> , Linn.....	...	M	K ⁴	
<i>Rhinoceros tichorhinus</i> , Cuv.....	X				„ <i>vulpes</i> , Briss.....	...	...	...	L
„ <i>leptorhinus</i> , Owen.....	X				<i>Lutra vulgaris</i> , Owen.....	...	...	...	L
„ <i>megarhinus</i> , Christol.....	X				<i>Mustela martes</i> , Ray.....	...	...	...	L
„ [<i>Etruscus</i> , Falconer].....	X				„ <i>putorius</i> , Linn.....	...	...	...	L
<i>Equus caballus</i> , Linn.....	...	...	L		„ <i>erminea</i> , Linn.....	...	M		
<i>Sus scrofa ferox</i> , Linn.....	...	M	K ¹		<i>Meles taxus</i> , Owen.....	...	...	...	L
<i>Hippopotamus major</i> , Nesti.....	X				<i>Gulo luscus</i> , Linn.....	...	M		
<i>Bison priscus</i> , Bojanus.....	...	...	K		<i>Ursus spelæus</i> , Blumenbach	X			
<i>Bos primigenius</i> , Boj.....	X				„ <i>arctos</i> , Linn.....	...	M		
„ <i>longifrons</i> , Owen.....	...	...	L		<i>Talpa europæa</i> , Schmerling	...	...	...	L
<i>Ovibos moschatus</i> , Pallas.....	...	M			<i>Sorex vulgaris</i> , Owen.....	...	...	...	L
<i>Capra hircus</i> , Linn.....	...	...	L		„ <i>moschatus</i> , Linn.....	...	...	...	L
„ <i>ægagrus</i> , Gmel.....	...	...	L		<i>Saiga tartarica</i> , Pallas.....	...	M		

X = Extinct.

M = Migrated.

K = Killed.

L = Living.

Of the names in brackets I will not say much, merely observing that the Forest-bed of the Norfolk Coast has yielded a most wonderful

¹ The wild boar *Sus scrofa ferox* has been killed off in England, but is still found in France and elsewhere on the continent.

² *F. spelæa* is extinct, but if considered equivalent to *F. leo* it has migrated.

³ *Hyæna spelæa* is extinct, but if considered to be the same as *Hyæna crocuta*, it has migrated.

⁴ Killed off in Britain.

series of Pre-glacial forms, associated with many which lived on into the Post-glacial period, and were known to man.

The most remarkable, perhaps, are (1) the gigantic Beaver, *Castor Trogontherium*, which occurs in widely-separated localities, viz., the Norfolk Forest Bed, and in a sandy deposit on the borders of the sea of Azof. Dr. Schmerling also found its remains in the Caves of Liege. Another gigantic Beaver has lately been found in America, the *Castoroides Ohioensis*, Fost. (2.) A remarkable form of deer, *Cervus Sedgwickii*, which occurs in the Forest-bed, and is nearly allied to *Cervus dicranios* of the Italian Pliocene. (3.) Another species of deer, closely allied to the Fallow Deer, the *Cervus Brownii*, lately described by Mr. Boyd-Dawkins, now quite extinct, from the Pliocene deposit of Clacton, Essex. See Quart. Journ. Geol. Soc. 1868. Vol. xxiv., p. 511. Pl. xvii. and xviii. (4.) The *Elephas meridionalis*, common to the Forest-bed and the Val' d'Arno, in Italy—a form somewhat more like the African than the Indian species as regards the arrangement of the enamel-layers of its molar teeth. 5. The *Rhinoceros etruscus*, found in the Norfolk Forest-bed, and also in the Val' d'Arno.

Animals known to man, but now extinct.—I have always felt some hesitation in accepting the statement that the *Machairodus* existed down to the Pre-historic period; but its discovery by the late Rev. J. McEnery, in Kent's Hole, in 1825 (published by E. Vivian, Esq., 1859), having been confirmed by Mr. Pengelly, F.R.S., in 1867, (see British Association Reports, Dundee, 1867), there seems reason to believe that it may have lived on till the commencement of this period. Certainly this was the most remarkable of the contemporaries of early man, and probably his most formidable rival in the hunting-grounds of Western Europe. The sabre-toothed lion has only been met with in this one cave in England, but it also occurs in the district of Auvergne, in France, and in the Val' d'Arno, in Italy. The largest species of this carnivore is found at Buenos Ayres, on the La Plata.

Of the species of Bear which occur in the fossil state, two at least, the *Ursus spelæus* of our caves, and the *Ursus priscus* of the Gailenreuth cavern, have been considered as well-marked extinct forms. The

Bears are, perhaps, of all the carnivora, the most difficult to determine, on account of their mixed diet and their consequent variable dentition : they have been as widely distributed in times past, as in our own.¹

Of the Cervine family, one extinct species, the *Megaceros Hibernicus*, or Gigantic Irish Deer, deserves especial notice. This splendid animal was not by any means confined to Ireland, although it is quite possible that it may have lingered on in that country after it had been exterminated in Britain. There is a fine specimen of the entire skeleton of this animal in the British Museum. The size of this deer is immense, even when compared with our largest living species; when erect, the topmost prong of his antlers was more than ten feet from the ground, and in breadth across they measured more than nine feet. The bones of the Irish deer occur in the beds of marl which underlie the peat-bogs, and they are generally very perfect, being stained more or less deeply by tannin or iron, and sometimes partially incrustated by pale blue phosphate of iron. Even the marrow of the bones occasionally remains in the state of a fatty substance, which will burn with a clear lambent flame. Groups of skeletons have been found crowded together in a small space, in a peat moss, with the skulls elevated and the antlers thrown back upon the shoulders, as if a herd of deer had fled for shelter or been driven into a morass and perished on the spot. Besides the numerous remains of this deer found in Ireland, its bones and horns have been obtained from Kent's Hole, the Forest-bed on the Norfolk coast, Kirkdale Cave, and numerous other localities.

Of the Oxen, the most ancient is the *Bos primigenius*. Professor Owen maintains the opinion that this gigantic ox (the *Urus* of Cæsar, which dwelt in the great Hercynian forest), was *never* tamed by the Britons or Romans, but was only an object of the chase. Its remains are alike common to the caves, the river-valley deposits, and the peat-bogs.

A grand head, and entire horn-cores, with a large proportion of the skeleton of *Bos primigenius*, was obtained from beneath the peat near

¹ The teeth of pigs, dogs, and bears, are all subject to considerable variation, owing to their mixed diet.

Cambridge. The peat had grown into and filled the cavities of the skull and all the bones. On the removal of the peat from the frontal bones, a stone celt was disclosed, broken off short in the forehead, which it had pierced, and had been apparently left there as useless by the hunter, to whose skill the mighty beast had fallen. The specimen is now in the Woodwardian Museum, Cambridge.

I was present at the disinterment of two magnificent pairs of horn-cores at Ilford, in the Brick-earth of the Thames valley, only a short time since. This species is readily distinguished from the Bison by the large size, length, and curvature of the horn-cores and by the form of the skull. *Bos primigenius* is found both in deposits with human remains, and in those anterior to man's era.

Of the *Elephants*, two forms, long confounded together, are now known to have been contemporary with man in Europe, viz., 1. *Elephas antiquus*, Falc., and 2. *Elephas primigenius*, Blum.

The former of these (*E. antiquus*) was long considered as identical with *E. primigenius*, but Dr. Falconer has shown that by the characters of the molar teeth they may be distinguished. 1st. By the narrowness of the tooth in proportion to its length and height. 2nd. By the great height of the plates, being twice that of the width of the crown. 3rd. Mesial rhomboidal expansion of disks of wear. 4th. Great crimping of the enamel plates.

The tusks of *E. antiquus* are nearly straight. The remains of this species are almost as widely distributed in our bone-caverns and River-valley gravels and Brick-earths, as are those of *E. primigenius*. No fewer than 2,000 elephants' grinders are recorded by my father, the late Mr. Samuel Woodward, as ascertained to have been dredged during a period of thirteen years upon the oyster-bed off Hasboro', on the Norfolk coast; "by far the largest number of these," says Dr. Falconer, "belong to *Elephas antiquus*."

Elephas primigenius (the "Mammoth," properly so called,) possesses unusual interest in connection with early man. Not only because it is one of those forms which, there is reason to believe, extended back into Pre-glacial times; but also because it is apparently brought so near our own day by the discoveries of entire bodies of this remarkable beast embedded in the frozen soil and ice

of the great rivers of Siberia and in Behring's Straits; no fewer than nine of which are on record. Its range in geographical area was equally great. It has been found in Ireland, Britain, through Europe, from the extreme north to the hills of Rome, and from France to the Ural Mountains, thence across Siberia into N. America, and southward to the Ohio, where its remains occur with those of the *Mastodon* in Big-bone-lick, Kentucky.

In October, 1864, I had the pleasure to visit Ilford, in Essex, and there see and examine the only existing cranium of *Elephas primigenius* with the tusk attached which has ever been obtained and preserved in this country. It is entirely owing to the skill and great practical judgment of Mr. W. Davies, of the Geological Department of the British Museum, that this fine fossil was ever raised from its matrix to adorn our National Museum.¹ No doubt hundreds of these remains have turned up in the valley of the Thames alone, but never before was the requisite skill brought to bear upon so unwieldy and friable a relic. The right tusk, which was found detached from the skull, measured ten feet ten inches, including the portion which in the left side is enclosed within the alveolus. From the top of the cranium to the end of the socket of the tusk is four feet. The circumference of the tusk, one foot from the socket, is twenty-six inches.

The three species of *Rhinoceros* are all extinct. Of the three—(1) *R. megarhinus*, or the great slender-limbed Rhinoceros, with largely-developed nasals, appears to be characteristic of the Norfolk Forest-bed and Grays Thurrock. It also occurs in France, associated with the *Mastodon brevirostris*, and in Italy with the *Mastodon arvernensis*. (2) *R. tichorhinus* and (3) *R. leptorhinus* are the two species common to the ossiferous deposits of our caverns, and they also are found together in the Brick-earth of Ilford. A unique skull (the only one known) of *Rhinoceros leptorhinus*, was obtained from the same brick-field at Ilford which yielded the Mammoth skull. We are indebted also to Mr. Davies for the preservation of this most valuable relic. All these Rhinoceri were *bicorn*, and resembled the Sumatran species. Like the Mammoth, the Rhinoceri had an enor-

¹ See GEOLOGICAL MAGAZINE, 1868, Vol. V., p. 540, Pl. XXII. and XXIII.

mously extended range in Pre-historic times. One of the earliest remains found in Russian Siberia, imbedded in ice, was an almost entire example of the great woolly *R. tichorhinus*, found in 1772 by Pallas, on the banks of a tributary of the Lena, lat. 64 degrees. This carcass emitted an odour like putrid flesh ; part of the skin was still covered with short, crisp wool, with black and grey hairs. The head and foot are preserved at St. Petersburg, in the Royal Museum.

Hippopotamus major.—As might be expected, the remains of the *Hippopotamus* are more frequently found in river-deposits than in caves. Yet this remark does not hold good in all cases. Remains have been found in one of the Gower Caves (Raven's Cliff), Durham Down Caves, in Kent's Hole near Torquay, Kirkdale, and other localities, but in the Grottoes of San Ciro and Maccagnone, in Sicily, the *Hippopotamus* remains formed by far the greater bulk. Many ship-loads of these interesting relics were quarried and sent to Marseilles and England to be used in sugar-refining ! Professor Ferrara, who examined the remains, stated that the great mass belonged to two species of *Hippopotamus*. Those collected by Dr. Falconer are preserved in the British Museum, and identified with *H. major* and *H. Pentlandi*. It is abundantly distributed through our River-valley, gravel and Brick-earth deposits, and occurs from Yorkshire southwards through England, France, Belgium, Spain, Italy, etc.

From observations of the habits of the living animal (*H. amphibius*) in South Africa, we learn that, where undisturbed, it frequents with equal pleasure the coast as it does the rivers, and that north of Port Natal they not only swarm in the rivers but upon the sea-shore, re-creating to the sea when disturbed or attacked. Such evidence as this enables us to understand the presence, in Pre-historic times, of the *Hippopotamus* in Britain during the summer, even after this country had been isolated from the Continent, although this seems not to have been the case, until nearly the close of the Quaternary period.

A species of Marmot (the *Spermophilus erythrogonoides* of Falconer), and another Rodent (*Lagomys spelæus*), a species of tail-

less hare, completes the list of extinct species contemporaneous with man. For, incredible as it may seem, it appears that after a careful investigation of the remains of *Felis spelæa*, the Cave-lion, Messrs. Boyd Dawkins and Sanford have concluded that it cannot be differentiated in *any way* whatever from the existing lion of Africa. And again that *Hyæna spelæa* is only a variety of *H. crocuta*, the great spotted Hyæna of S. Africa.

We now pass therefore to *Animals whose geographical distribution* has been changed. These we can analyze more fully than the extinct forms before enumerated; and they arrange themselves naturally into two divisions—those which have migrated north, and those which have migrated south.

The first division, as you will have anticipated, is by far the largest of the two, including nine species. The second consists of two only (the Cave-lion and Cave-hyæna already referred to).

Spermophilus citillus.—The “Pouched Marmot” is the first. Its remains have been found at Fisherton, the Mendip Caves, and elsewhere in England, and also in the Liege Caverns. It is still met with in northern and central Europe, near the snow-line.

The Lemming (also found at Fisherton, near Salisbury) is now represented in Lapland, Norway, Greenland, Siberia, and Arctic North America. Its migratory and gregarious habits have been ably described by Richardson and others.

Ovibos moschatus.—The “Musk-ox,” or “Musk-sheep,” possesses peculiar interest, as one of those generalized species still left us, which we were long at a loss where to place with certainty, whether with the Oxen or the Sheep. M. Lartet has shown, however, reason for placing it with the *Ovidæ* and *Capridæ*. The gravel of the Avon, the river-gravel near Maidenhead, and Green Street Green, in Kent, and the Crayford brick-pits, in the valley of the Thames, have all yielded examples of this animal. It has also been detected by M. Lartet in France. In Siberia its remains occur in the frozen mud of the great rivers, which yield the bodies of the Mammoth, along the whole line of the shores of the Polar Sea. Its living habitat is now the barren,

treeless wastes of the high northern latitudes of North America, and our Arctic voyagers have traced it and lived upon it so lately as 1856. Captain (now Sir Leopold) M'Clintock gives the following statistics of the Musk-ox in a paper read before the Royal Dublin Society, 25th January, 1857:—Musk-oxen on Melville Island, April 4 and May 13, saw 59 (shot two); third visit, July 1 to 19, saw 30 (shot two); Prince Patrick's Island, May 14 and June 26, saw 5 (shot three)—total seen, 94; number shot, seven. They were so unused to man's presence that, when one of a herd was shot, it was often difficult to induce the rest of the party to move off, so as to allow M'Clintock and his men to take possession of their fallen comrade. We cannot help contrasting this brave and noble sailor's conduct with that of the Laird of Lamont. M'Clintock observes, "We never killed more than we absolutely needed." Mr. Lamont, on the contrary, gives a list of walruses and other victims "*shot for pastime*," and left to render still more desolate with their decaying carcasses these northern seas.

The "Saiga Antelope" deserves a word. It has lately been determined as occurring in the caves of France, with the reindeer, etc. An antelope is recorded as being found fossil, together with several species of deer, beaver, wild boar, etc., in shell-marl beneath peat, near Newbury, in Berkshire, by Dr. J. Collet, F.R.S., in 1757.—(Phil. Trans.) May not this also have been the Saiga antelope? It is now found to inhabit the eastern slopes of the Ural Mountains, and the shores of the Sea of Azof. On a small island a number were found living, so tame as to be undismayed at a discharge of fire-arms. It is to be seen alive in the Zoological Gardens. It is the only tapir-snouted antelope known.

Ursus arctos.—The "Brown Bear" occurs both in Britain and Ireland. Undoubted remains from Longford, in Ireland, and Manea Fen, Cambridgeshire, are preserved in the British Museum. It still lives in Russia. So lately as A.D. 1057 bears were natives of Scotland and Wales, and reckoned among the beasts of the chase, equal to the hare or the boar (Ray, Syn. Quad. p. 214).

Gulo luscus.—The "Wolverine," or "Glutton"—was once a native of this country, as its remains testify from the caverns of

Banwell, Bleadon, and Gower. It is still common in Siberia and North America, and is the pest of the fur-hunters of those countries.

Mustela erminea.—The “Ermine” is another of the Weasel tribe, now gone North-east, and over the Ural chain into Siberia.

Alces malchis.—The “Elk” has been met with in Scotland, at Chirdon Burn, beneath peat, in a similar deposit as the *Megaceros* in Ireland. A lower jaw also has been obtained from Llandebie Cave, in South Wales. It is the true Elk of Norway, or Moose-deer of the Canadians.

If we take into consideration the relative importance of the various animals to man in his hunter state, the whole list is probably surpassed by the Reindeer (*Cervus tarandus*). Not only do we find its remains in greater profusion than that of any other animal in those caves in which man undoubtedly resided, but his weapons were for the most part fabricated from its horns, bones, and sinews; and doubtless, his clothes were composed of its skin. The later investigations of Mr. Pengelly, at Torquay, have led to the discovery of similar barbed javelins of Reindeer horn to those of the French Caves. That fewer cut antlers have been found in England than in France, may be due to the more savage condition of the early Britons; but it cannot be attributed to lack of the reindeer. In Boscoe’s Den, Gower, South Wales, more than 1,000 antlers have been obtained by Colonel Wood; indeed, their remains are almost co-extensive with the cavern and river-valley and peat-deposits. It is reasonable to suppose that the reindeer may have retained a footing in Scotland even long after the Roman occupation of Britain; but it must have yielded, if living there, not only before the pursuit of the chase by man, but also before the overpowering influence of the red-deer, *Cervus elaphus*, and still more to the great change in physical conditions which affected our climate. That the reindeer could continue to live for long in Britain after its isolation from France, seems unlikely, for the migratory instincts were as strong in the race then as at the present day. The only change produced has been to modify the area which the migration formerly extended over. Instead of migrating southward in winter, from Norway and Denmark into France and Britain, they are not only

pressed northward by the great tide of human beings which has occupied their former territory, but also by the change in the thermometer. Vast as was the range of the reindeer in past times, we see how enormous is its kingdom in our own day. Through Northern Europe, Asia, and America, it occupies the area from the edge of the woods to the farthest northern latitude, crossing the frozen sea fearlessly in vast herds from land to land. Sir Leopold M'Clintock mentions seeing, on Melville Island, in April and May, on two visits, 29 head of reindeer, two of which he shot. In July, on two visits, he saw 74, and again shot one. On Prince Patrick's Island, in May and June, he saw eight, and shot five. On Emerald Island, in June, 13 head; being a total of 124 head seen in these three far northern islands, between 76° and 77° North lat.

When migrating in Siberia, says the Russian Admiral von Wrangel, the migrating body may consist of many thousand head of deer, and though they are divided into herds of some 200 or 300 each, yet they always keep so near as to form only one immense mass, sometimes 60 miles in length. In crossing the rivers they all follow the same route. They select a place where a dry valley leads down to the stream on one side and a flat sandy shore facilitates landing on the other. As each separate herd approaches the river, the deer draw more closely together, and the largest and strongest buck takes the lead. He advances, closely followed by a few of the others, with head erect, and apparently intent on examining the locality; having satisfied himself that all is right, he enters the river, the rest of the herd crowd in after him, and in a few minutes the surface is covered with them. It is doubtless due to casualties in these migrations that we owe some, if not all, of our reindeer bones in river-valley deposits. Detached antlers may easily be explained where they occur in quantities (as in the peninsula of Gower, in South Wales) by the annual shedding of the horns; but most of those from the Caves have a part of the skull attached to the burr of the horn. This is so in more than 50 from the Cave of Bruniquel, which have passed through my hands.

In many of the Caverns of Central and Southern France we have abundant evidence that the wild Horse was largely eaten by the

Cave-dwellers, and that its bones formed an important article for the fabrication of many of their weapons of the chase, and also for their needles. Remains of Horse are abundant in the Bruniquel Cave.

Of the animals now living, but become extinct in some regions, the Beaver—*Castor Europæus* (or *Castor fiber*? of Canada) from being killed by man is, probably, quite extinct in Europe. Only one refuge seems left to it by any chance, and that is the mouths of the Danube in the Euxine Sea, where its fossil congener is found. It was formerly abundant in our Welsh rivers, even at a late date, comparatively speaking. It was scarce in the 9th century, in the 12th it was only found in one river in Wales, and another in Scotland. There can be no doubt the Beaver was killed off the face of the land for the sake of his fur coat. His remains are abundant in the Cambridgeshire fens, and he did his best to divert the rivers and destroy the land for his own pleasure, but like other selfish pleasure-seekers, his would-be pools became peat, and in it are embedded the bones of the curious, ingenious, but destructive rodent, who aided the mischief.

In a single night, not long since, the Beaver at the Zoological Gardens diverted all the water of his pond, by the introduction of mud into his tank, and sent several dozen gallons of very dirty water over the gravel walk. He wanted to make a dam—failing which he made a mess!

The Lithuanian Bison—preserved by Imperial ukase of his Majesty the Emperor of all the Russias—once roamed the Prairies of Europe as his congener now does those of America. But he couldn't be tamed and made to plough like *B. longifrons* and *B. taurus*, and so the natives killed him off, and he would be soon extinct, like his old rival *primigenius*, but for the Emperor.

The wild boar and the wolf were only killed yesterday. The former (*Sus scrofa ferox*) abounded in Henry II.'s time, whilst the latter (*Canis lupus*) survived in Ireland till 1710. Blood-money was put upon his head as upon the tiger in India at the present day. The present foxes are mostly re-introduced, and owe their existence to *Protection*. The Wild-cat, Badger, Marten, Pole-cat, and even the

Otter, are becoming rare as British species. These all owe their extinction to man. The Red Deer, Roebuck, and Fallow Deer only exist by means of protective legislation.

Of birds, the Capercaillie, or "Cock of the Wood," is extinct with us, though still occurring in Norway. The two Bustards (*Otis tetrax*, the little bustard, *Otis tarda*, the great bustard), are both exterminated. Formerly they could live on the wastes of West Norfolk and Wiltshire. The great Crested Grebe—*Podiceps cristatus*, the great Bittern—*Botaurus stellaris*, and the freckled Heron, *Botaurus lentiginosa*, once rejoiced in the Fens of Cambridgeshire and Dorset. The fen-lands are gradually becoming drained and cultivated, and these birds are mostly dead. The White Spoon Bill (*Platalea leucorodia*), the White Stork (*Ciconia alba*), and the little Glossy Ibis (*Falcinella igneus*), once were summer visitants of ours, now they come no more. The Herons are fast dying out, and require "Protection" like the Grouse and Partridges. The Golden Eagle and numbers of *Falconidæ* and lesser birds of prey have also been lost.

Among the interesting associations of the past, to the Naturalist, will always be counted the Great Auk, once an inhabitant of the Orkneys and the shores of Denmark, found in the Kitchen-Middens of both, and also in the Indian Shell-heaps of New England. The last of his race is believed to have perished so lately as 1846. And no wonder! for the poor bird could not fly, so the old Danish sailors used to lay a plank from the ship to the shore, and compel their unfortunate victims to "Walk the plank," "single file," and fall into the ship's waist, where they were killed and eaten. One skipper boasted that he had brought off thirty boat-loads in an hour. Once this bird covered the shores of the north—Labrador, Nova Scotia, Newfoundland, Greenland, Iceland. Now we look in vain for a single one.

The Dutch sailors were just as merciless to the Dodo in the Mauritius, and the Maories to the *Dinornis* and the Great Rail in New Zealand, and the people of Madagascar to the *Epyornis*.

Changes (insensibly it may be, yet, nevertheless, surely) are going on year by year around us. We see but little in the lifetime of an

individual ; but the retrospect of a century shows vast changes in our condition as a race for example.

Each step in retrogression will appear more and more marked.

Go back a century, where are our railroads, our telegraphs, our steam-vessels, our rifled cannon ?

Still further, and we have not our colonies, and the world is only half-known.

Further still, and we have not learned Christianity, and worship idols ; we are ignorant, superstitious, and cruel. Still further, and behold the savage depending on the chase, trusting to his instincts to supply his wants. And now to ignorance, superstition, and cruelty, he has added dirt ; for he is not at all particular about his abode, provided he be dry, warm, and his hunger appeased. His life was not one constant state of alarm—indeed, he was happier in this respect than his black representative of to-day. The Negro lives in a stockaded village in terror. Why ? Because, although slavery is at an end in North America, it is not quite ended elsewhere ; and the cruel passions that ardent spirits and vice have engendered in the slave-trading population of the coast, seek gratification in acts of cruelty and violence, often of a far more terrible nature than any pre-historic savage would have invented.

There can be little doubt that the designation, "*the noble savage*," belongs almost entirely to the past. If we except the New Zealanders, the savage races of to-day are probably, as a whole, less civilised than the men of the French caves and the Swiss pile-works. Witness the Andaman Islander, the Terra del Fuegian, and the Australian native.

The old Cave-men represented the population of the less-civilised portions of the globe, as these aborigines do now in our own day ; for there never was a time in the Earth's past history when a uniform condition of things obtained, unless in pre-Silurian epochs.

Faunas slowly but constantly migrate, a part becoming extinct, some races improving, some remaining persistent.

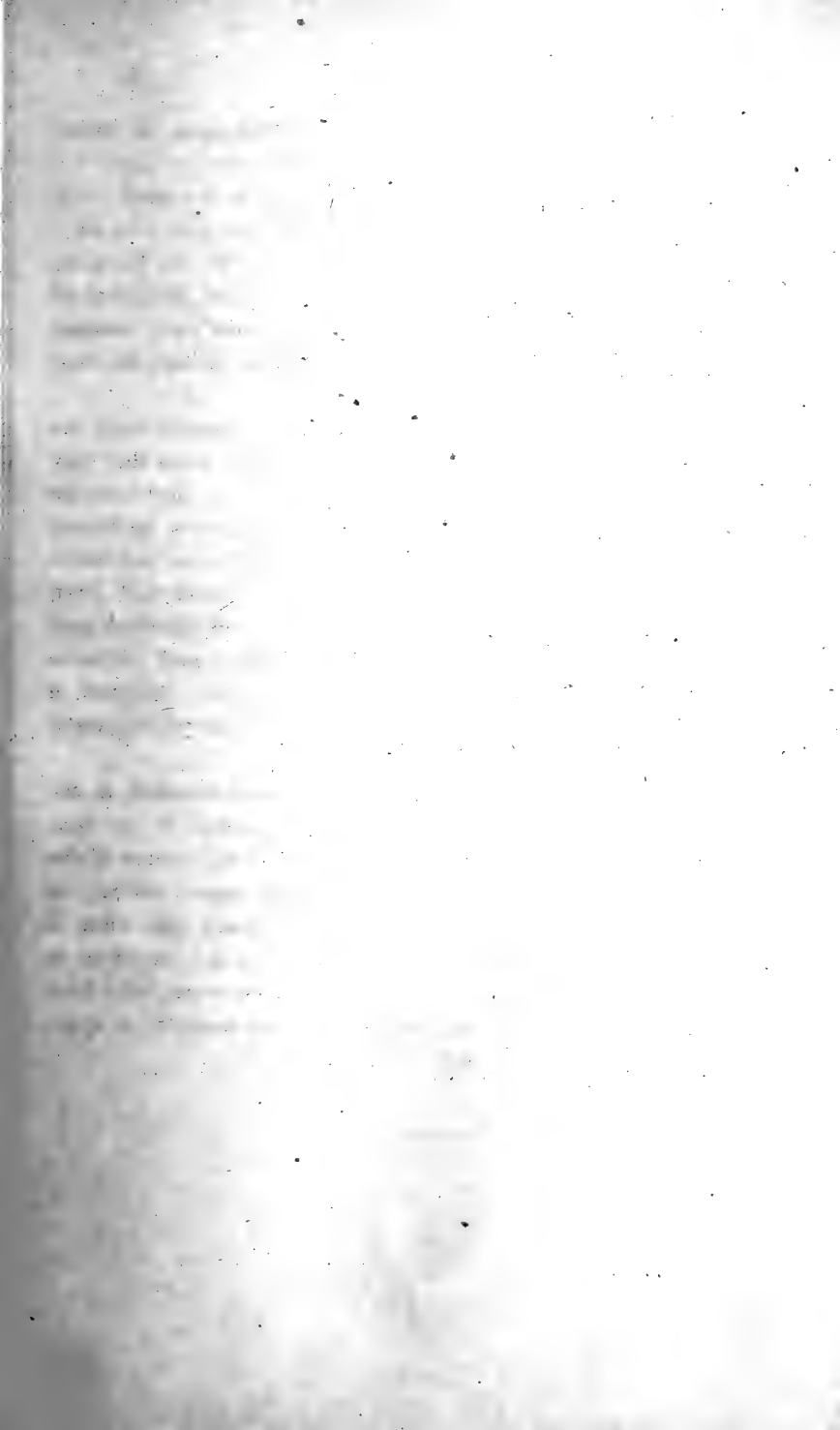
Peoples migrate—some are exterminated (witness the native races dying out before the over-mastering effects of a too-advanced white civilization)—the remainder in part improve (being, as individuals,

capable of improvement) those which remain unchanged, do so because they are not exposed to the elements of change.

There is little doubt that man has been upon the earth long enough to have witnessed many physical changes, and even considerable modifications in the climate of Europe. We can the more readily accept this, because from the brief portion of the record of our race embraced in the historic period, we know that many changes in physical conditions have come to pass, and some, indeed, are even now taking place around us.

The duration of the Pre-historic period, as compared with the historic, may best be conceived when it is borne in mind that very old countries like India, whose history goes back further into the past than any other, have still a lost history apparently far longer than that handed down to us, evidenced by Megalithic and other monuments of unknown antiquity; and again, beyond that, Prof. Blanford; Messrs. King, Foote, Wynne, and other of the Geological Surveyors, have obtained evidence of a still earlier and barbarous race, whose only relics are their stone-implements, fashioned of the Neolithic and Palæolithic types, like those of the aborigines of Gaul and Britain.

How many thousands of years must have been occupied in the gradual distribution of these earliest representatives of our race, whose implements have been found in almost every portion of the globe (formed in the same simple yet persistent types), can only be realized by the geologist who has learnt that many prior races of beings lived and spread out over the whole globe, and have been as gradually exterminated and re-placed with other races, who have followed in successive eons, differing in form, yet modelled on types analogous to those now existing.





GEOLOGISTS' ASSOCIATION,

1869.

ON

THE CHIEF GROUPS

OF

THE CEPHALOPODA.

BY

THE REV. THOS. WILTSHIRE, M.A., F.L.S., G.S.

"WHEN FOUND, MAKE A NOTE OF IT."

CAPTAIN CUTTLE.



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Presented by B. B. Woodward F. G. S. 21. 11. 88



ON THE

CHIEF GROUPS OF THE CEPHALOPODA.

(A Paper read before the Geologists' Association, Nov. 1st, 1867.)

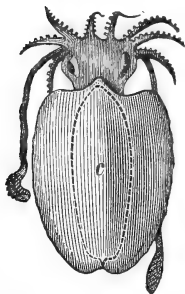
THE title of this paper may, perhaps, appear to some persons who are not well acquainted with technical expressions, as a form of words ambiguous and far from clear, conveying, indeed, no certain evidence whether the subject to be illustrated pertain to the Animal or Vegetable kingdoms, or, on the other hand, be significant of Minerals and Rocks. I purpose, therefore, in the first place, to interpret the term Cephalopoda; next, to note the connection of the group referred to with the world around us, and finally to treat the matter by the aid of scientific teaching.

The name 'Cephalopoda,' it will be observed, has not an ordinary English sound, in truth it is a Greek compound word, not classical, nor to be found in ancient authors, but belonging to modern times and modern writers. The term is composed of *κεφαλή* and *πούς*, that is, of "head and foot," implying a something which is "head-footed," which has the head not far distant from the foot, the two being closely connected and brought together. The mention of a head and foot necessarily implies that that something which we have in view must have a *body*, and that therefore that something belongs to the *Animal Kingdom*, to beings which are possessed of vital powers, have a will, and entrap their prey; inasmuch, however, as this something is head-footed, has the organs of locomotion and prehension arranged around the head, we gather that a Cephalopod must be organised upon a plan unlike the creatures we generally see flying in the air, moving on the land, or swimming in the water.

One of the Cephalopoda (or rather a portion of the frame of one of that family) is not unfamiliar to us under a different and less scientific aspect. No rambler along the beach, in search of the marvels of life left by the falling tide, can have avoided seeing that common object of the sea-shore called a "Cuttle-Bone," a small white oval body, six or more inches in length, convex on both surfaces, very hard on the one side, very soft on the other, and light in weight. This Cuttle-Bone (a section of which is a beautiful microscopic subject, consisting of thin laminæ or floors of chalky matter, supported by myriads of minute pillars)¹ is the internal support² of a certain species of Cephalopoda called *Sepia officinalis*, a denizen of English waters, abundant enough beneath the waves, though rarely to be found in an unmutilated condition on the shore.

For a moment let us try to realise this creature, this inhabitant of our seas, by doing so we shall be the better able to comprehend the marked distinctions which separate these beings from our ideal type of ocean life. We shall perceive they neither correspond to Fish, Crustacea, nor Shell-fish, to "Sea-flowers," nor "Dead-mens'-fingers," that they are exceptional, and yet that they are in a certain sense their relatives.

FIG. 1.



Sepia officinalis, drawn from a specimen preserved in the College of Surgeons.

To picture this Cuttle-fish, *Sepia officinalis* of naturalists, we must draw an oval obtuse-cone-shaped body, then affix to the sides a flexible line of fins, insert two large eyes at the broadest portion of the cone; place in juxtaposition with those eyes ten long arms, attach to those arms a series of saucer-shaped suckers, and, lastly, hide away within the fleshy cone the cuttle-bone itself.

We have then, in this portrait, an ideal representation of the general aspect of the Cephalopoda, conspicuous chiefly and most notably for the arrangement of a fixed number (either eight or ten) of long moveable and flexible arms around the head, the arms being fur-

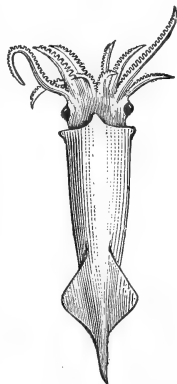
¹ An excellent representation is given in Quekett's Lectures on Histology, fig. 216, D, page 341.

² The position which the cuttle-bone occupies in the Cuttle is seen in the dotted lines in the woodcut, fig. 1.

nished with hollow discs like cupping glasses,¹ and radiating from the head, and being its crown, giving us indeed a type of fishy animal, just such as one would think would belong to the visions of the night, rather than to sober reality.

During a recent visit to Folkestone in Kent, I had the opportunity of seeing in a living state a member of this family, *Loligo media* (fig. 2), and had the gratification, for a short period, of inspecting its habits. In a rock pool near the limits of low water mark, my attention was one day directed by my son to what at first sight seemed to be a small fish, almost transparent in texture, of about four inches in length, and possessed of a singular property of darting backwards² in the pool, and of changing the colour of its body. On attempting to secure this creature, I found the usual fish's head was wanting, and in place of this, a ring of ten moving arms, from the base of which a pair of gleaming eyes glared at me in a defiant manner not the most reassuring. Unpleasant as were the eyes, no terms significant of mother-of-pearl, or of the rainbow, can describe the lovely varying metallic lustre, which, whilst life remained, sparkled in those orbits. On attempting to capture this strange fish, another characteristic became observable, for the small pool hitherto transparent and glittering in the sun, suddenly and without warning became of a dingy tint, caused evidently by the ejection of a dark coloured fluid from the Cuttle, which, mixing immediately with the water, concealed it for a few moments in a dusky cloud. This protection,³ furnished by

FIG. 2.



Loligo media (Common Squid), drawn from the actual specimen. The Squids differ from the Cuttles in their internal bone being more transparent and elongated.

¹ In certain genera of the Cephalopoda, as in the uncinated Calamary (*Onychoteuthis*), the interior of the "cupping glasses" contains a hook-like appendage adapted for firmly holding the soft and slippery surfaces of fish; a specimen can be seen in the College of Surgeons.

² The Cuttles produce this retrograde movement, by rapidly ejecting streams of water from a pipe situated at the back of the head.

³ Long ago noticed by Aristotle. Hist. Anim. Lib. ix. cap. 37. "But the most crafty of the Mollia is the Cuttle-fish, which alone employs its ink or black liquor for the sake of concealing itself, and not only when terrified."

nature and available for escape in the open sea, was of course valueless in a rock pool; of necessity only a brief interval sufficed to make the ten-armed *Loligo* a captive of its two-footed spectators.

Preserved in spirits, all the beauty of the Cephalopod faded out of view, the transparent body gradually was converted into an opaque and dirty white substance marked with light red spots; the rainbow-looking eyes, previously so bright, ceased to attract attention, and all that before had seemed ideal, became clothed in the garb of poor mortality. The general form, however, was retained, perhaps in a better condition for study and inspection. The cause of backward progression, the method of obtaining food, the nature of the tentacles, and the cup-like appendages, all these were set forth in a manner clearer than had been the case whilst there had been life and activity.

Writers on Natural History tell us the Cuttle-fish tribe is very highly organised, and approaches in structure, though not in shape, to the Vertebrate or back-bone animals. The Cephalopoda have a brain, very efficient eyes, (sometimes furnished with eyelids), a well-planned ear, strong power of taste, most excellent parrot-like beaks¹ for cutting up their food, and means not to be despised for pursuing their prey and overcoming their foes.

Formidable indeed, if travellers are to be believed, must be some of the tribe which inhabit the southern seas. In those waters, it is related, certain Cuttles have arms fifty feet in length, giving a diameter of 100 feet to the circle at the mercy of the creature. Arms very terrible, in that they occasionally clasp a passing canoe in a horrible embrace, and drag down to the bottom both boat and boatmen.²

Taking, however, such accounts for what they are worth, I would rather turn to a statement which sounds more probable, and so I will refer to the narrative of a naturalist, bearing upon the case of an Octopus or eight-armed Cephalopod, and the more readily because the description places the creature very graphically before our view.

¹ The *Rhyncholite*, a fossil found in the Cretaceous and Jurassic rocks, is supposed to have been the biting jaw of a pre-historic Nautilus: for figure see D'Orbigny, *Paléontologie Française*, Terrains Jurassiques, Vol. I., Plate 39.

² Pennant, *British Zoology*, vol. iv., p. 45.

A certain Mr. Beale, we are told,¹ whilst searching for shells among the rocks of the Bonin Islands, unintentionally became on intimate terms with a companion of this description. Looking downwards, the collector beheld a curiously shaped animal crawling towards the surf. It was creeping on its eight legs, which from their soft and flexible nature, bent beneath the weight they had to carry. On seeing the stranger, it appeared much alarmed, and made every effort to escape. To secure the strange fish, Mr. Beale first with his foot pressed upon one of its long arms with his whole weight, but with all the pressure possible could not detain it; next he tried to detach it from the rock by manual force, but here again the suckers would not yield. Finally a powerful jerk was tried, but was of no avail except to change the creature's fear into excessive rage. For the Cuttle suddenly retracting its suckers and bounding upwards, sprang upon its assailant's elbow, fastened on the bare skin, and tried with its beak to tear the flesh. The writer adds it would be hard to describe the sensation of horror which was felt when the cold slimy tentacles clasped the skin, and when the suckers glued themselves down in a hundred different places. So firmly did the Octopus hold, that not until a sailor, attracted by the cry for help, had with a boatman's knife cut off the clinging tentacles, not until then, could Mr. Beale obtain release from a situation of so much danger.

If these many-footed beings have their unpleasant aspect, so have they their pleasant. According to ancient authors, the fashionable diner-out of Greece and Rome was often feasted with Cuttle-roasts and Cuttle-hashes. Athenæus, in his "table-talk," thus pleasantly addresses a hungry man who arrived too late for the commencement of a festive banquet.²

"The dainty slices of fat, well-seasoned sausages
Have all been eaten. The *well-roasted Cuttle-fish*
Was swallow'd long ago, and nine or ten
Casks of rich wine are drained to the very dregs,
So if you'd like some fragments of the feast
Hasten and enter. Don't, like hungry wolf,
Losing this feast, then run about at random."

¹ Beale's Natural History of the Sperm Whale, p. 67. London, 1839.

² The Deipnosophists, Lib. xiv. cap. 17. Yonge's Translation.

The same Greek writer puts into the mouth of a distinguished man-cook the speech which follows¹ :—

“ I took the *Cuttles*, cut off their fins,
Added a little fat, and then did sprinkle
Some thin shred herbs o’er all for seasoning.”

What were customs then, in part remain customs now. In the south of Europe, at the seaports, Cuttles are still sold, to grace the tables of epicures who admire this delicate food, and who, like Athenæus, are of the opinion —²

“ Don’t be too expensive, still not mean,
Get some small *Cuttle-fish*, some little *Squids*.”

Such then are some of the manners, habits, and uses of a part of the large family of the Cephalopods, (whom we best know by a portion of their body, viz., the “ cuttle-bone” of the chemists’ shops, that substitute for blotting paper in the days of our forefathers), a family roughly to be defined as possessing a head crowned with arms, in place of hair ; furnished with suckers instead of claws, and invested with armour, which is beneath their skin. This armour beneath the skin, in other words, an internal support, either the Cuttle-bone of our shores, or the Sea-pen of naturalists, or the Spirula-shell of the Atlantic,—this internal support forms a most important element in the division of the group, being the sign that all the creatures which possess it, need extra means of protection from their foes, and require additional aids to save them from extinction.

And so we find, that the Cephalopoda, having an internal bone, whether Cuttles or Squids, whether without fins or with fins, whether with simple suckers or horny hooks, that these, in their varieties (and the list is long), are possessed of an ink-bag, a most curious provision of defence, by which they can blind their foes by jerking ink at them, a habit man sometimes copies, when he throws dust in other people’s eyes—and we discover by investigation that they have moreover two sets of gills, a vigorous circulation, sharp eyes, and well furnished arms, gifts counterbalancing the evil of a naked body, seemingly so defenceless.

¹ The Deipnosophists, Lib. vii. cap. 130.

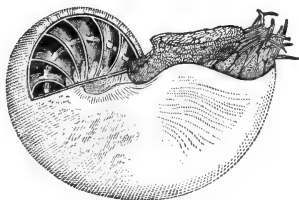
² The Deipnosophists, Lib. vii. cap. 87.

The mention of Cephalopoda with an *internal* support implies also the existence of Cephalopoda with an *external* shield. The type of this last group is met with in the Pearly Nautilus,¹ whose beautiful outline and splendid lustre, are known to all.

Professor Owen, in a memoir² written on the subject, has very fully pictured and described the being which owns the Nautilus-shell as its house and home, and has shown the wonderful adaptation of parts and means to an end, which in that, as in every other case of Nature's works, strikes a thoughtful beholder. Not the least curious characteristic in reference to the Nautilus animal, is its shell (fig. 3), a castle capable of excluding doubtful spies, the floors for strengthening the castle walls, the machinery for repairing damages, and lastly, the absence of an ink-bag, and the existence of a less vigorous frame, two things not required, when there is a house for habitation, and a door which can be locked.

For a moment let us investigate the shelly covering alone, and note its most conspicuous parts. Externally we find a case (fig. 3) of thin calcareous substance, elegantly designed in agreement with that curve called an involute or flat spiral, the case itself having slightly compressed sides, a rounded back, and an opening of some size. On our cutting a transverse section of this case, marvellous seems the arrangement of the internal parts, the whole being divided into rooms by pearly walls and floors, each room after the outer and

FIG. 3.



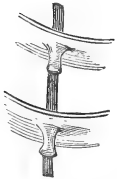
Nautilus pompilius, (Pearly Nautilus) drawn from a specimen in the College of Surgeons. A portion of the shell has been removed to show the siphuncle and empty chambers, part of the valve-like mantle and the brachial tentacles of the animal are seen projecting from the mouth of the shell. These tentacles correspond to those of the *Loligo*, but are more numerous and without suckers; the mantle acts as an operculum.

¹ Aristotle, in his History of Animals, Lib. iv., cap. 1, gives us the name, and very clearly describes the nature of the Paper and the Pearly Nautilus in the following terms. "There are also two other genera of polypi which are in shells, one of which is called by some Nautilus and by others Nauticus. This genus resembles a polypus (πολύπους), and the shell is similar to a hollow pecten (κτέις), but is not perfectly affixed to it (συμφυής). . . . there is also another polypus, which is covered with a shell like a snail, so that it never leaves its shell, but sometimes outwardly extends its arms."

² On the Pearly Nautilus. London, 1832.

most exterior, mathematically diminishing in size, yet each room having a connection with the next, by a tube inserted in a short hollow pillar (fig. 4). This short hollow pillar occupies the centre

FIG. 4.



Pillar descending from the floors of the chambers in the Pearly Nautilus, and serving as a partial protection to the Siphuncle.

of each floor, and follows the same curvature (only of less radius) as that which the outer edge of the Nautilus presents when placed on the flattened side. Rich then is the creature in rooms, truly the possessor of a many-roomed house, but miser-like, it occupies only one, the exterior and largest. When it outgrows this one, it sets to work to build another chamber, puts in a floor, adds a descending pillar, shuts up the old apartment, and having removed to the more modern chamber, lives as before, but with increased accommodation.

The use of the hollow tube or siphuncle (see figs. 3 and 4), partially enclosed in a series of short and unconnected calcareous pillars, and the reason for the empty rooms or chambers, have given rise to speculations not a few. Of these the most reasonable refer the hollow pillar as a protective covering to a membrane arising from the heart, which membrane also touching the walls of the empty chambers can secrete shelly matter, and accordingly repair injuries to its external covering. The empty chambers also are supposed to act as a counterbalance against the animal's weight, making the whole mass almost of the same specific gravity as that of sea-water, and therefore causing that mass to be capable of being raised or depressed in the ocean by a slight muscular expansion or contraction of the body of the creature.

Respecting the habits of the Nautilus in a living state, recent investigations prove that it seizes small shells, crabs, and such like things; that with its hardened beaks, it breaks through their outer coverings and drags forth their inmates; that when pursuing its usual course, or when in search of prey, it creeps along the bottom of the sea, head downwards; and that only after storms, as though driven upwards by under currents, does it rise towards the surface, remaining there a little while, with tentacles outspread upon the water, but never raising them by way of sail.¹

¹ The tradition of the Nautilus sailing on the surface of the waves has reference in reality to the Paper Nautilus (fig. 5), and that only in a mistake.

Alas, how imagination breaks down by the side of sober facts: many have been the metaphors, much the poetry,¹ written for the last eighteen centuries, all to show how merrily the Nautilus outspreads his sails to the summer's breeze; how, when the breeze freshens, he sinks beneath the waves; how he leads a simple harmless roving life;—and now we find he walks upon his head, crunches up little crabs, and does not possess a single sail.

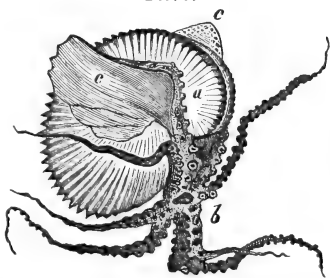
I have thus set forth the two great divisions of the Cephalopoda, as evidenced in the beings of that class inhabiting the present seas.

The one great group, the Dibranchiata of Owen, being marked (with one exception) by an internal bone or shell, sometimes comparatively oval and solid as in the Sepia (fig. 1), sometimes thin, slight, and elongated as in the Loligo (fig. 2), sometimes bent evolutely and chambered as in the Spirula,—the animal itself being always furnished with an ink-bag for defence, and two gills for respiration. The other and second group (Tetrabranchiata) marked by an external and chambered shell, as in the Pearly Nautilus (fig. 3), and by the animal itself being provided with a kind of door to its house, having also four gills for respiration, but destitute of any ink-bag.

As a note, I ought to add that the famous Paper Nautilus or Argonaut (fig. 5), seems to exist as an intermediate link between these two groups, the Dibranchiata (two-gilled), and the Tetrabranchiata (four-gilled), having a relation to the first, in that it has two gills and an ink-bag, but connected with the second, in the possession of a shell, which said shell is also exceptional, from the fact of its consisting only of one chamber and having no siphuncle.

Great has been the controversy relating to the creature which in-

FIG. 5.



Argonauta argo (Paper Nautilus) drawn from a specimen preserved in the College of Surgeons, represented in its natural position; on the side of the shell is the partially expanded tentacle, erroneously supposed to act as a sail.

¹ *E.g.* "Learn of the little Nautilus to sail,
Spread the thin oar, and catch the driving gale."—POPE.

habits the shell sketched in fig. 5. Aristotle wrote at first (*Hist. Anim. Lib. ix.*) that "touching the growth of the shell nothing is as yet exactly determined." Naturalists contended that the animal itself was destitute of testaceous covering; that it was parasitic; that it made use of the Argonaut shell much in the same way as the Hermit Crab of our shores occupies the first vacant Winkle which is of convenient or suitable size. In confirmation of this theory was adduced the fact that a Dr. Moffat caught in the Madras Roads an Octopus, which had its unprotected body firmly inserted in an Indian Ghee-bowl, and that a M. Desjardins found another species comfortably lodged in a *Dolium* shell. Moreover, it was affirmed that the Argonaut had been seen quitting the shell, and moving about without any protective covering, as though the absence of its house was of small moment; finally, that specimens procured in a living state gave no sign of being affixed to the shell itself by any method of muscular attachment.

To a Madame Power is due the merit of clearing up in a great measure these opinions; that lady, in November 1836, described a series of experiments made by her at Messina, which testified to the Argonaut not being dependent for a home upon others' labours. Madame Power, causing a number of small cages to be constructed, enclosed in these the Argonauts, and sinking the cases in the sea, examined from time to time the doings of the prisoners. It was then discovered that the Cephalopod always met with in the Argonaut shell, had the power of repairing¹ fractures in its testaceous covering with similar testaceous material, that it remedied these injuries by means of its so-called "sails" (fig. 5), that these sails were closely applied to the whole of the sides of the shell (much more than in the woodcut, where the tentacle is shrunk and somewhat distorted, from the action of the spirits in which the specimen is preserved), that, as the Argonaut animal increased in bulk,² so did the shell in magnitude, and that there was

¹ Several examples of self-repaired Argonaut shells can be seen in the Museum of the College of Surgeons.

² In the same Museum are many specimens of the Paper Nautilus shell with the Cephalopod inside, of various progressive sizes, commencing with one smaller than an inch in diameter.

always a correspondence in size between the two. Further, it was noted that the eggs of the Argonaut, when developed, produced a shell-less Cephalopod with rudimentary eyes and arms, but that this same naked infantine Cephalopod in a few days became coated with a Nautilus-like shell. These facts, three years later, were also demonstrated before the Zoological Society in a paper by Professor Owen, illustrated by specimens furnished by Madame Power.

The questions relating to the Argonaut's sails, and the true nature of their owner, already briefly mentioned, do not comprehend the extent of the difficulties in deciphering this denizen of the ocean, which investigation has suggested. The learned in the Cephalopoda some time since noting that the Argonauts hitherto found, appeared to be females, asked where were the males, and in consequence propounded two theories, one,—that the male avoids public places, and so keeps to the bottom of the sea, and is unknown; the other that the male is a mere worm-like creature (*Hectocotyle*¹) an inch or so long, without a shell, which being very feeble, for safety's sake makes the Argonaut's abode its own, as tenant-at-will, rather than as freeholder,—theories which have failed.²

Resuming then the preceding observations, it will be found we have viewed the Cephalopods as divisible into two large groups,—first, the *two-gilled*, including the Cuttles with eight arms, the Squids with ten arms, both with internal supports, the Argonaut with an external, and the *Spirula* with a partly internal shell; and the second, the *four-gilled*, containing the Nautilus.

These divisions, treated more in detail, would have resolved themselves into numerous families and genera—a long series of names,³ with which I will not now weary you,

If the Geologists' Association were content with the knowledge of such beings as can be found upon our own shores, or may be met

¹ See paper by Prof. Kölliker of Zurich, published in Trans. Linnean Soc., vol. xx., p. 9, 1851.

² Dr. Müller in the *Annales des Sciences Naturelles*, t. xvi., described, in 1852, the male Argonaut as being a creature of very small size, shell-less and Cephalopodic in shape, and also explained the true nature of the *Hectocotyle*.

³ In Appendix I., at the conclusion of this paper, will be found a complete list of the families of the recent Cephalopoda, with a brief description of each genus; and in Appendix II. the same with respect to the fossil Cephalopoda; Appendix III. gives the range in geological time of the latter group.

with on foreign seas, it would suffice to close at the present stage the rough outline I have sketched of the Class Cephalopoda, but as the Members of this Society care for the life-history of the past, no less than for the relics of the present, it becomes incumbent upon me to show that, in the ages gone before, there also lived that same curious group of objects, cousins far removed in family from our modern Cuttle-fish, yet true relations every whit.

Conspicuous amongst these were the "Thunder-stones" (fig. 6), that puzzle of the 15th and 16th centuries, that once Bogey of many a child in witch-haunted districts. Simple enough to look at, not dissimilar in shape to the cedar lead-pencils of the present century, to what wonders have they not borne witness—how that in the storms

FIG. 6.



A common Chalk Belemnite (*Belemnitella mucronata*), about four inches in length; some in the Lias measure more than twelve inches.

they came down from heaven, how that they were the fingers of the Evil One, how that they spontaneously sprang from the ground, how that they could cure festering wounds and other ills to which

flesh is heir,—these strange forms, once superstitiously regarded, afterwards viewed in a more reasonable light, were eventually proved to be the internal bone of some of the race of the Cephalopods.

The Belemnite, taken by itself, would of necessity be likely to prove a puzzle, the more so as it has small analogy outwardly with things which exist at the present day. For what have we?—an almost straight cylinder pointed at one end, conically hollow at the other; when perfect, with the conical hollow filled with another chambered cone, partitioned with gradually decreasing lower floors, and pierced by an aperture.

It is to the late Dr. Buckland¹ that the merit is mainly due of discovering the connection between the Belemnite and the Cephalopods' internal bone, for that learned divine, working at the Lias fossils

¹ In February, 1829, Dr. Buckland read a paper before the Geological Society of London (printed afterwards in Abstract of Proceedings Geol. Soc., vol. i. p. 97). in which he argued that certain fossil ink-bags surrounded by nacreous plates (phragmocone) discovered at Lyme Regis, in Dorsetshire, were probably portions of the Belemnitic Cephalopods. Subsequently, in 1836, Dr. Buckland figured in the Bridge-water Treatise (Pl. 44¹, fig. 7) an ink-bag in the midst of nacreous chambers, to which chambers the ordinary Belemnite was attached, proving that the ink-bag, the nacreous partitions, and the Belemnite itself were all parts of the same animal.

of the Dorsetshire Coast, found a bag-shaped mass containing a dark substance capable of being used as a pigment, and producing the effect of sepia in a water-colour drawing, a specimen of which, or of a similar attempt, can yet be seen in the Museum of the Geological Society of London, thus perpetuating again what the Roman Poet Persius tells us of his countrymen, and of the ink from the Cuttle-fish, then in use eighteen centuries ago.

I give the quotation from Persius¹ in the words of Brewster's² effective translation :—

“ At length his books he spreads, his pen he takes,
His papers here in learned order lays,
And there his parchment's smoother side displays ;
But oh, what crosses wait on studious men !
The Cuttle's juice hangs clotted on our pen ;
In all my life such stuff I never knew,
So gummy thick — Dilute it, it will do, —
Nay, now 'tis water.”

Succeeding observers found more certain impressions of the body of the Belemnites then of the tentacle hooks, next of the arms, finally of the relative position of the various parts ; and so knowledge went on increasing,³ and better specimens came to light until a result was gained, such as we find set forth in the sketch (fig. 7), drawn from a fossil preserved in the British Museum,

FIG. 7.



Belemnites
Bruguierianus
D'Orb. Lower
Lias. Char-
mouth. British
Mus. Reduced
1-7th. The ink-
bag is seen to-
wards the top
of the figure,
the tentacle
hooks still
higher.

¹ “ Jam liber, et bicolor positis membrana capillis,
Inque manus chartæ, nodosaque venit arundo.
Tunc queritur, crassus calamo quod pendeat humor,
Nigra quod infusa vanescat Sepia lympha ;
Dilutas queritur geminet quod fistula guttas.”—Sat. III. v. 10.

² London, 1751.

³ See an elaborate paper by Professor Owen, read before the Royal Society, March 21, 1844, on “ Certain Belemnites preserved with a great proportion of their soft parts in the Oxford Clay of Christian Malford, Wilts ;” the specimens can now be inspected at the College of Surgeons. See also Monograph II., British Organic Remains, the Belemnitidæ, in the Memoirs of the Geological Survey. In this monograph by Professor Huxley, published in 1864, a review is taken of the observations of previous observers, and many new facts introduced ; the paper contains figures and descriptions of the new and very peculiar Lias form the *Xiphoteuthis* (Pl. III.) in shape like an elongated double-pointed Belemnite ; the originals are in the British Museum and in Jermyn Street Museum. See also the Belemnitidæ by Professor Phillips, now in the course of publication by the Palæontographical Society.

where we have the outline of a creature, of which the lower part consists of the familiar Belemnite, the middle of the chambered partitions, and the upper of a body surmounted by a crown of radiating

FIG. 8.



Belemnoteuthis antiquus, Oxford Clay, Christian Malford, Wilts.; the figure reduced one-seventh from a specimen in the British Museum. The hooks seen on the left-hand side of figure are those belonging to the arms, and are reduced to half the natural size.

arms, clothed on the one side with sharp and effective hooks; or in the drawing (fig. 8), where one of the Belemnitic tribe seems as it were to come before us bodily.

What were the Belemnite's ways, how it lived, also seems revealed to us, viz., that it was gregarious, that it was fond of company, avoided rocks and sported on muddy shores, was wont to swim backwards, ever ready to secure its prey, and always inclined to flee from any impending danger. Called into existence in the Lias Age, suddenly swimming in the Lias seas in perfect shoals, it held its ground for ages; continually, from time to time, putting on new shapes, until in the soft bottom of the Chalk ocean, it assumed a fresh generic form, that of *Belemnitella*,¹ and passed away extinct, never to be found again in any sea or ocean.

In addition to the Belemnites, few are the other fossils which pertain to our first great group, the outwardly unclothed, such as they are, as the *Belemnoteuthis*, (fig. 8,) or the *Beloteuthis*, with a spear-headed bone, or the *Belosepia*, with a tooth-formed bone, are related to the Cuttle, that is to say, they have an internal support; when alive they possessed an ink-bag, and were covered by bare skin. These for the most part occur in the deposits overlying the Lias formation, and pertaining to the Jurassic system of Geologists.

Henceforth when new continents rose up from the recesses of the deep, other strange fish entered on their labours, and swept up and cleaned anew the new-born ocean-floors.

In the second of the two great divisions, that of the "head-footed" creatures enclosed within a shell, the best known and the most com-

¹ *Belemnitella* differs from *Belemnites* in the presence of a small slit at the side of the conical hollow, "alveolar cavity;" it is well marked in fig. 6. In the Belemnite there is only a furrow.

mon fossils are the Ammonites (fig. 9), named from the circumstance that they resemble the ram's horn found on the statues of the old heathen deity, Jupiter Ammon, and also from the fact that they had in idol times (so it is asserted) a place in the worship of that deity. Not unlike a coiled-up snake¹ in contour, the belief came that they were stony serpents converted to this rigid form, as a judgment on their evil deeds. Sir Walter Scott has charmingly described to us in the poem of *Marmion*² that



FIG. 9.

Ammonites interruptus,
a Gault form.

“ Whitby's nuns exulting told,

 And how, of thousand snakes, each one
 Was changed into a coil of stone
 When holy Hilda prayed ;
 Themselves, within their holy bound,
 Their stony folds had often found.”

Marvellous as seems the tale, still more marvellous is the Ammonite itself ; in plan and in design exhibiting a most complicated internal structure and lovely outside pattern. Similar to the Nautilus in the possession of sets of chambers, and of a communicating hollow pillar (this tube being in the Ammonite on the outside of the rooms), it also surpasses the Nautilus in the intricacy and undulations of its floors (fig. 10), so involved and so arranged that they form a petaloid figure—a contour appearing on and intersecting the outside surface of the walls, something after the shape of those divisions on our skulls called sutures.



FIG. 10.

View of the undulating partitions (Septa) dividing the shell of the Ammonite into chambers ; drawn from a specimen of *A. interruptus* from Gault of Bonchurch, Isle of Wight.

I fear that words cannot express the ideal plan ; but if you will conceive the floor of a room to undulate, say in two cross waves, and if you will imagine each

¹ This is especially true of the common Whitby species, *Ammonites communis*, with the small exception of being destitute of headpiece ; a difficulty the Yorkshire curiosity-dealers overcame by carving the requisite member. See a picture of one in Sowerby's *Mineral Conchology*, Plate 107, fig. 2.

² Canto II. 13. The same tradition is described as an ancient belief by J. de Laet, in his *Book on Gems*, p. 109, 1647.

crest of these waves to be again presently affected by half-a-dozen little additional waves, and these half-dozen to each assume an arborescent form, and the whole suddenly to become rigid, you will perhaps realise the floors and ceilings of the Ammonite's dwelling, which in contact with the outside walls, present radiating lines of a foliaceous pattern in the cast of the shell.

FIG. 11.



Sketch of *Ammonites splendens* (Gault) showing the leaf-like traces of the undulating Septa, depicted on the sides of the fossil.

A foreign geologist, M. de Buch, investigated these complex waves on the surface of the floors and found, wonderful as it may appear, that every species of the family has its own wave-pattern, impressed upon its sides, and is thus stamped, as it were, with its own proper name, written in a writing which was penned by the Most High in the primæval age.

Numberless almost are these species of Ammonites.¹ Already something like eight or nine hundred have been described; and this has by no means exhausted the list. Nay, wherever the Palæontologist sets his foot, and seriously sums up the Ammonites at his disposal, fresh forms and fresh shapes reward his research.

These species were not created at haphazard and scattered over the ancient world, just as a sower sows his seeds; on the contrary, first one particular type was founded, and then another, and this so marked, that if an Ammonite is placed before a person versed in such learning, he can tell from its style of ornament and curvature whether it came from the Liassic, Oolitic, or Cretaceous beds.

It would weary you, to give you these type groups, it will suffice that they comprehend about 21 sets,² named the tuberculated, the sickle-bearing, the narrow-ribbed, the crowned, and so on, significant of the particular ornamentation and appearance special to each group.

Each Ammonite—as one of a species or family, say (to be familiar) that of Smith or Robinson—had few ancestors, Smith soon

¹ In Morris' Catalogue of British Fossils, 1854, all the English species of Ammonites described up to that period are noted.

² Von Buch and D'Orbigny have treated this idea at some length; illustrations and remarks will be found in Chenus' Manuel de Conchyliologie, 1859.

gave way to Robinson, and Robinson to Brown, and Brown quickly sunk to rest in the graveyards beneath the waters.

And thus it has happened that Ammonites play a very important part in telling the hours, nay the minutes, on the clock-face of Geological time. Given an Ammonite, it marks much more than a mere type group, it points out a particular zone. So that if in boring a well, or sinking a shaft, we meet with an Ammonite, we know (within a very few feet) from that specimen what will be the kind of sand, or clay, or stone, to be brought up in the next succeeding borings.

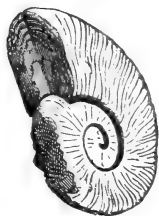
Connected with the Ammonites is another curious fossil, which was for a long time the subject of much controversy: it is a thin triangular-looking object (*Aptychus*) generally cellular on one surface and smooth on the other, having two of its edges nearly straight, and the other curved.

Some writers had put the whole group down as a species of shell, others thought that they were parts of the internal organization of Ammonites. At last a lucky blow solved the mystery; in the interior of an Ammonite, accidentally split asunder, these two triangular bodies were observed reposing side by side, and fitting the opening of the Ammonite, thus proving they were the folding-gates, most securely strengthened, of the Ammonite's castle.

The Ammonites as a genus first appeared in the Triassic age, having been preceded by forms with simpler sutures, the Goniatites, with the septa folded in angular undulations, and the Ceratites in a combination of circular and linear lines. Like the Belemnites, the Ammonites¹ ended in the Cretaceous age, are never seen in the newer rocks, nor have they ever been met with living in modern waters.

Looking at the general shape of the Ammonite, you will perceive that it may be roughly taken as a cylinder, which is continually

FIG. 12.



Ammonites subradiatus, with operculum in situ, drawn from the original specimen, No. 39,627 in the British Museum, size of operculum $\frac{1}{2}$ inch by $\frac{3}{8}$.

¹ Their size varies from a few lines to several feet in diameter; large forms are seen in the Lower Chalk and Portland Oolite.

rolled round upon itself in one plane. Now if you try to consider what variations of form you can produce with a flexible cylinder (keeping to regular curves), and if you write down all these variations as they occur to you, I think you will find when you look over your list that you will have been outwitted by Nature.

Of course you can make your cylinder straight;—Nature thought of that, for this form is the common *Baculite* of the Chalk-marl (fig. 13); or you can make one or two bends in the straight cylinder,

FIG. 13.

*Baculites baculoides*, after D'Orbigny.

in this you have the *Hamite* (fig. 14); or you can place the straight bends in contact,—what is this but the *Ptychoceras*? or you can twist

FIG. 14.

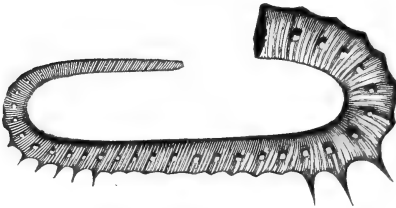
*Hamites armatus*, after D'Orbigny.

FIG. 15.

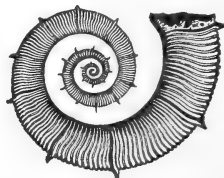
*Turritites Scheuchzerianus*, after D'Orbigny, a common Lower Chalk form, sometimes a foot and a half in length.

your cylinder like a spiral, with the curves touching, and you produce the *Turrilite* (fig. 15), or with the curves not touching, as in the *Helicoceras*; or you can make a bow and so realize *Toxoceras*; or you can form an *Ammonite*, lengthen out one end, and bend over the

FIG. 16.

*Ancyloceras gigas*, from the Lower Greensand, sometimes a couple of feet in length.

FIG. 17.

*Crioceras Cornuelianus*, from the Lower Greensand, after D'Orbigny.

extremity when you build up the ordinary Scaphite; or you can take care the parts do not touch when there is immediately presented to you *Ancyloceras* (fig. 16); or you can increase the radius, cut off the end, and you behold *Crioceras* (fig. 17).

These variations upon the general arrangement of the twists are essentially Cretaceous, for though one or two are known to have existed before the Cretaceous beds were deposited, it is in the sands and clays of this formation that they were at a maximum, some on one horizon, some on another, and then they died.

A few more words and I will cease to weary you. The *Nautilus* (see Fig. 3), living in the present seas, dates back its ancestors into remote ages, a very noble member of the aristocracy of shells.

Far removed in the Silurian times, with forms of life which have long since passed away, the *Nautilus* sprang into existence. It knew of the foliage of the Coal-bearing districts; of the Coral-reefs which arose in Oolitic days; of the vast stream which furnished the broad expanse of the Wealden Delta; of Mammals coming into being, and of the Fish¹ putting off their bony armour; of the bright Spice Islands that flourished where we now have our ships of war; of the change in climate in the northern lands from tropical heats to polar frosts;—it saw man a mere savage, working with flint tools; then better instructed, forming an iron ploughshare; lastly, busy with his merchandise, master of the electric current, putting his girdle round the world, and speaking with the tongue of the lightning's flame.

Like the *Ammonite*, the *Nautilus* had relatives of similar organization, but clothed in diverse frames; now being straight, as in the case of the *Orthoceras*; now copying a bishop's crook, as the *Lituite*; now a rough double cone, as the *Gomphoceras*; now of a curved pear form, as the *Phragmoceras*; now with the whorls not in one plane, as the *Trochoceras*; now evolute, as the *Cyrtoceras*. All these creatures of the *Nautilus* tribe were of the ancient times, fitted no doubt for a special office, suited for requirements and conditions lasting whilst they swam in the old waters in the pursuit of prey as

¹ The modern representatives of the armour-plated fish, such as the Sturgeon, etc., are now in the minority.

strangely fashioned as themselves. In the primeval rocks of Europe, Asia, America, and Africa, they rest to be disinterred by chance or purpose, to be rolled down the mountain's side by the winter's storm, or to be upturned by the pickaxe of the workman.

All these—the Cephalopoda—clothed in a shelly case, came forth abundantly when man was not. Man arose, events were changed, and the Ammonitidæ and the Nautilitidæ, some time chief citizens before the advent of the human race, dwindled down in numbers, and became almost extinct, to be exhibited at last as rarities (the medals of creation) in the cabinets of the curious; and to be classified, and finally arranged in learned books, from the standpoint of the Geologist.

Thus I bring to a close this very rude and imperfect sketch of the chief groups of the Cephalopoda¹ only hoping, that if out of the storehouse at my command, I have set forth some things new and old, the new may serve the members of our Association, as germs for future papers, the old for profit and reflection.

¹ The following books amongst others illustrate the subject:—D'Orbigny. *Paléontologie Française*, Ter. Crét., vol. i., Paris, 1840.—Pictet. *Traité de Paléontologie*, vol. ii., pp. 309-387, Paris, 1845.—Edwards. *Eocene Mollusca* (Palæont. Soc.), pp. 1-56, London, 1849.—Quenstedt. *Cephalopoden*, Tübingen, 1849.—Woodward. *Manual of the Mollusca*, pp. 62-97, London, 1853.—Sharpe. *Chalk Mollusca* (Palæont. Soc.) London, 1853.—Chenu. *Manuel de Conchyliologie*, pp. 3-102, Paris, 1859.—D'Eichwald. *Lethæa Rossica*, vol. i., pp. 1189-1327, Stuttgart, 1860.—Huxley. *Mem. Geol. Survey*, Monog. ii., London, 1864.—Phillips. *Belemnitidæ* (Palæont. Soc.), London, 1865-69.—Barrande. *Système Silurien*, vol. ii. Prague, 1865-68.

APPENDIX I.

SCHEDULE OF THE LIVING CEPHALOPODA.

DESCRIPTION OF THE CLASS.

ANIMAL possessing a shell either internal (in this case *naked*) or external. Upper part of BODY, when naked, attached to and inserted in a bag-like fleshy covering (*mantle*, *sac*) which is externally cylindrical, conical or oval, produced upwards at its highest portion, so as to form a collar about the base of the head; upper part of *mantle* sometimes in actual contact with the base of the head by means of a band (*la bride cervicale*, as in the Octopoda), sometimes *not* in contact, but retained in place by muscular bands, and by ridges fitting into corresponding grooves (*l'appareil constricteur*, as in most of the Decapoda). External surface of mantle and head marked by pigment spots (*chromophores*) which dilate and contract, and vary in tint through the emotions of anger, fear, etc., acting on the creature. BODY generally marked by openings (*aquiferous pores*) leading into recesses of greater or less depth in the head, base of arms, and near the mouth and eyes. FINS, when present, lateral or terminal, rounded or angular. INK-BAG generally present. HEAD crowned with eight (as in the Octopoda) or ten (as in the Decapoda) slender prolongations of the body (*arms* and *tentacles*) of unequal length; the tentacles, two in number, occurring in the Decapoda, always much longer than the arms and usually expanded at their termination (*tentacular clubs*). ARMS and TENTACLES provided with cup-like suckers (*acetabula*), which are sometimes strengthened by a horny margin, sometimes dentated at their edges, sometimes on a stem, and sometimes furnished with a central hook or claw. SUCKERS arranged in a single line, or in a series of two or four, or six or eight rows, or without order. MOUTH in the centre of the arms, circular with a muscular lip, and a tongue armed with recurved spines. JAWS with a horny parrot-like beak. EYES large, projecting, sometimes provided with eye-lids, sometimes raised on prominences. GILLS (*branchiæ*) internal, plume-like, sometimes two (as in the *Dibranchiata*), sometimes four (as in the *Tetrabranchiata*). A funnel shaped tube (*infundibulum* or *siphon*) sometimes valved, placed on the under (*ventral*) side of the body, serving to eject the water used in respiration, and to produce a rapid backward motion of the creature by the reaction on the surrounding fluid. SHELL generally internal and straight, lance-like in form, with or without a stem, either rudimentary or absent (as in the Octopoda), or cartilaginous (as in the *Squids*), or cellular as in the *Cuttles*; sometimes external and curved, with the turns

rolled in the same plane and forming a single chamber (*monothalamous*, as in the Argonaut), sometimes with the turns rolled in the same plane and over-lapping and divided into many chambers (*polythalamous*, as in the Nautilus); sometimes partly internal and partly external with the turns in the same plane and not in contact (as in the Spirula).

ARRANGEMENT OF THE CLASS.

The recent Cephalopoda are divided into two orders, first, the Dibranchiata, with two gills, of which there are few fossil representatives, and secondly, the Tetrabranchiata, with four gills, to which the fossil genera of this class mostly belong.

The former of these (the Dibranchiata) includes the sections of the Octopoda (with eight arms) and the Decapoda with eight arms and two tentacles); and the latter, the Tetrabranchiata, comprises the Nautili, with many arms, and the allied fossil forms, of the Ammonites, Ceratites, Goniatites, Clydonites, etc.

The sections of the Octopoda and Decapoda are separated into families and genera distinguished by the attachment of the head, the position of the fins, the plan of the arms, the arrangement of the suckers, etc., and may be thus tabulated.

Dibranchiata	Octopoda...	I. Octopidæ	1. Eledone	
			2. Bolitæna	
			3. Cirroteuthis	
			4. Octopus	
			5. Scæurgus	
			6. Pinnoctopus	
		II. Philonexidæ.....	7. Philonexis	
			8. Tremoctopus	
			9. Argonauta	
	Decapoda...	IV. Onychoteuthidæ ...	10. Enoploteuthis	
			11. Abralia	
			12. Octopodoteuthis	
			13. Ancistrocheirus	
			14. Onychoteuthis	
			15. Dosidicus	
			16. Ommastrephes	
		V. Chiroteuthidæ	17. Thysanoteuthis	
			18. Chiroteuthis	
		Tetrabranchiata...	VI. Gonatidæ.....	19. Histioteuthis
				20. Loligo
				21. Gonatus
			VII. Lorigopsidæ	22. Rossia
				23. Sepioteuthis
VIII. Fidenidæ	24. Lorigopsis			
	25. Sepiola			
IX. Sepiadæ	26. Sepioloidea			
	27. Fidenas			
	28. Cranchia			
X. Spirulidæ	29. Sepia			
	30. Spirula			
XI. Nautilidæ	31. Nautilus			

ANALYSIS OF THE FAMILIES AND GENERA OF THE LIVING CEPHALOPODA.

FIRST ORDER.—DIBRANCHIATA (Owen, 1832),¹ CONTAINING SECTION I., OCTOPODA, AND SECTION II., DECAPODA.

Section I. of First Order.—The Eight-armed Cuttles, OCTOPODA (Leach, 1817).

OCTOPODA.—BODY round, oval, or conical, furnished with eight arms. MANTLE united to the head by a broad band, sometimes strengthened by lateral ridges fitting into corresponding side furrows in the part adjacent to the funnel. FINS generally absent. EYES fixed. ARMS with one or two rows of suckers, which are without horny margins and not on prominences (pedunculated). SHELL generally absent, sometimes internal and rudimentary, sometimes external and developed. Nine GENERA, Eledone, Bolitæna, Cirroteuthis, Octopus, Scæurgus, Pinnoctopus, Philonexis, Tremoctopus, and Argonauta, separated into three divisions (A. B. C.) according to the connection of the mantle with the head.

I.—DIVISION A.—MANTLE *without* side ridges; arms united by a membrane, Octopidæ, D'Orbigny, 1845. Six Genera, Eledone, Bolitæna, Cirroteuthis, Octopus, Scæurgus, and Pinnoctopus.

(a.) *One row of suckers on the arms.*

- | | |
|---|--|
| 1. Eledone, Leach, 1817 | Body oval, the arms united at their <i>base</i> by a membrane, no fins. |
| = Eledon, Cuvier, 1817. | |
| = Moschites, Schneider, 1835. | |
| 2. Bolitæna, Steenstrup, 1858 | Body oval, arms united at their <i>base</i> by a membrane, no fins, suckers small. |
| 3. Cirroteuthis, Eschricht (1836) 1838. | Body round the arms united their <i>whole length</i> by a membrane, hairs alternate with the suckers, transverse fins. |
| = Sciadelporus, Reinh, 1846. | |
| = Bostrychoteuthis, Agassiz, 1847. | |

(β.) *Two rows of suckers on the arms.*

- | | |
|---------------------------------------|---|
| 4. Octopus, Lamarck, 1799 | Body oval, the arms long, united at their <i>base</i> by a membrane, no fins. |
| = Cistopus, Gray, 1849. | |
| 5. Scæurgus, Troschel, 1857 | Body oval, the arms short, no fins. |
| 6. Pinnoctopus, D'Orbigny, 1845 | Body oval, the arms united at their <i>base</i> by a membrane, lateral fins. |

II.—DIVISION B.—MANTLE *with* side ridges, two of the arms of greater length than the rest, suckers in two rows. Philonexidæ, D'Orbigny, 1845. Two Genera, Philonexis and Tremoctopus.

- | | |
|--|--|
| 7. Philonexis, D'Orbigny, 1839 | The arms not united by a membrane. |
| 8. Tremoctopus, Delle Chiaje, M.S., 1835 | Some, or all of the arms united by a membrane. |

III.—DIVISION C.—MANTLE supported by a single ridge, body of female enclosed in a shell, with two of the arms much expanded at their extremities, male shell-less. Argonautidæ, Reeve, 1841. One, genus, Argonauta.

- | | |
|---------------------------------|---|
| 9. Argonauta, Linné, 1758 | The shell thin, involute, single chambered not moulded upon the animal. |
| = Ocythoe, Rafinesque, 1815. | |

¹ The name which follows each order, etc., is that of the author who described the order, or family, or genus; the figures are the dates of publication of the order, etc.

Section II. of First Order.—The Ten-armed Cuttles, DECAPODA (Leach, 1817).

DECAPODA.—BODY oval or elongated, with ten arms; two called tentacles, very much longer than the others, with expanded terminations (tentacular clubs). MANTLE generally not united by a band to the head, strengthened by side and vertical ridges fitting into corresponding grooves in the body. FINS always present, lateral or terminal. EYES capable of motion, and either covered by a transparent skin, or exposed to the water. ARMS with two or more rows of suckers, which are on prominences, have horny margins, and are sometimes possessed of a central hook. TENTACLES more or less retractile, often very long, terminating in an expanded extremity, furnished with hooks or suckers. SHELL (*pen, gladius*), generally internal, lance-shape, longitudinal, (1.) HORNY, or (2.) CALCAREOUS, or (3.) CHAMBERED and curved, partly external. FUNNEL generally valved. Twenty-one genera, Enoploteuthis, Abralia, Octopodoteuthis, Ancistrocheirus, Onychoteuthis, Dosidicus, Ommastrephes, Thysanoteuthis, Chiroteuthis, Histiototeuthis, Loligo, Gonatus, Rossia, Sepioteuthis, Loligopsis, Sepiola, Sepioloidea, Fidenas, Cranchia, Sepia, and Spirula, separated into several groups by the nature of the internal shell, the plan of the mantle, and the aspect of the eyes.

1. *The Horny Shelled Cuttles, with ten arms, TEUTHIDÆ (Owen, 1838).*

TEUTHIDÆ.—ANIMAL having a *horny* internal shell, belonging to the divisions A. and B.; (A.) of those without a head-band to mantle, and (B.) with a head-band.

DIVISION A.—Of the horny shelled cuttles, Teuthidæ, having the MANTLE not united by a band to the head, either with (I.) eyes naked (*without a covering membrane*), or (II.) with a covering membrane.

I. *Eyes naked, without a covering membrane, Oigopsidæ (D'Orbigny, 1841).*

IV.—First group of the naked-eyed Cuttles, having a horny internal shell without a head band. MANTLE strengthened by tubercles fitting into corresponding recesses. FINS lateral or terminal. HEAD of moderate size. EYES with a lacrymal sinus. ARMS often furnished with hooks or claws in addition to suckers. TENTACLES often provided with hooks in addition to the suckers, and sometimes with special suckers for bringing both tentacles into contact. FUNNEL with a valve. Onychoteuthidæ (Gray, 1847). Eight genera, Enoploteuthis, Abralia, Octopodoteuthis, Ancistrocheirus, Onychoteuthis, Dosidicus, Ommastrephes, and Thysanoteuthis.

(a.) Arms and tentacles furnished with hooks.

- | | |
|--|---|
| 10. Enoploteuthis, D'Orbigny, 1839 ... | Body elongate; fins terminal, triangular, arms with two series of concealed hooks; pen without projecting termination, sides often curved. |
| 11. Abralia, Gray, 1849..... | Body conical; fins terminal, triangular; arms with hooks at their base and suckers at their extremities, tentacles with suckers alternating with hooks; pen with concave sides. |

12. *Octopodoteuthis*, Rüppell and Krohn, 1844.
= *Veranya*, Krohn, 1847. Body conical; fins covering nearly the whole of the back, rather rounded; arms with suckers in two rows concealing hooks, tentacles very short; pen lanceolate with a marked longitudinal ridge.
13. *Ancistrocheirus*, Gray, 1849 Body elongate; fins covering nearly the whole of the sides, triangular; arms with two rows of hooks without cups, tentacles long, with large hooks; pen narrow-lanceolate.

(β.) Arms with suckers having horny margins, tentacles furnished with hooks.

14. *Onychoteuthis*, Lichtenstein, 1818...
= *Onychia* (partim) Lesueur, 1821.
= *Ancistroteuthis*, Gray, 1849. Body somewhat elongate; fins terminal, triangular; arms with two rows of suckers, tentacles in part retractile, furnished with hooks in the upper part of, and with suckers at the base of the club; pen curved, narrow, contracted near the upper part, with a hollow conical point at its lowest extremity.
15. *Dosidicus*, Steenstrup, 1856. Body elongate; fins terminal, arms with large suckers at base, at extremities small.

(γ.) Arms and tentacles with suckers having horny margins.

16. *Ommastrephes*, D'Orbigny, 1845 ... Body elongate; fins terminal, triangular; arms with two rows of suckers, having a dentated margin on the upper side; tentacles not retractile, with four rows of suckers; pen long, with the sides contracted towards the base, with a central and two marginal ribs, the apex hollow, conical, without septa.

(δ.) Arms and tentacles without hooks, arms fringed.

17. *Thysanoteuthis*, Troschel, 1857 Body elongate; fins lateral as long as the body; pen arrow-shaped.

V.—Second group of the naked-eyed Cuttles having a horny internal shell, without a head band. MANTLE strengthened by ridges, fitting into grooves at the base of the funnel and on the back without a neck band. BODY short. FINS terminal rounded. HEAD large. Eyes *without* a lacrymal sinus. ARMS long, united or not by a membrane. TENTACLES very long, not retractile, with four or six rows of suckers. FUNNEL *without* a valve, *Chiroteuthidae* (Gray, 1849). Two genera, *Chiroteuthis* and *Histio-teuthis*.

18. *Chiroteuthis*, D'Orbigny, 1839 Arms with two rows of suckers on stalks; tentacles with small cups along their whole length, terminated by four rows of cups on stalks carrying claws; pen slender, lance-shaped at both extremities.

19. *Histioteuthis*, D'Orbigny, 1839..... Arms, with the exception of two united by a membrane, with two rows of suckers on stalks; tentacles with six rows of stalked cups having a dentated margin; pen short and broad.

II. Eyes covered by a transparent membrane, Myopsidæ.
(D'Orbigny, 1841).

VI.—Group of the eye-covered Cuttles having a horny internal shell without a head band. MANTLE strengthened by ridges and grooves. FINS generally terminal. HEAD as wide as the body. ARMS with two or four rows of suckers. FUNNEL generally valved. Gonatidæ. Four genera, *Loligo*, *Gonatus*, *Rossia*, and *Sepioteuthis*.

20. *Loligo*, Lamarck, 1799 Body long, conical; fins terminal, triangular; arms with two rows of suckers, tentacles with four; pen long, lanceolate, multiplied in number by age.
21. *Gonatus*, Gray, 1849 Body long, conical; fins terminal, triangular; arms with four rows of suckers; tentacles with many rows of small suckers, and a larger one with a hook at the base; no valve; pen lanceolate.
22. *Rossia*, Owen, 1835 Body somewhat short, cylindrical; fins terminal, somewhat triangular; arms webbed at the base, suckers irregularly disposed in two or four rows; tentacles completely retractile, with irregularly arranged suckers; pen small, lanceolate.
= *Heteroteuthis*, Gray, 1849.
23. *Sepioteuthis*, Férussac, 1825 Body somewhat oval; fins lateral, as long as the body; arms short, with two rows of suckers; tentacles partly retractile, with four rows of suckers; pen horny, long, lanceolate, strengthened by a strong middle rib.
= *Chondrosepia*, Leuckart, 1828.

DIVISION B.—Of the horny shelled Cuttles, *Teuthidæ*, having the *mantle united by a band to the head*, with eyes naked or the reverse.

VII.—*I. Eyes naked*, without a covering membrane, *Oigopsidæ* (D'Orb.)
Loligopsidæ (Gray, 1840). One genus, *Loligopsis*.

24. *Loligopsis*, Lamarck, 1812..... Body elongate; mantle supported by one dorsal, and two ventral muscular bands; fins terminal, curved; arms with two series of suckers on stems, and with horny margins; tentacles not retractile, slender, with scattered suckers; pen slender, lanceolate, with a minute conical appendix.
= *Leachia*, Lesueur, 1821.
= *Perothis*, Eschscholtz, 1827.

VIII.—*II. Eyes covered by a transparent membrane* (*Myopsidæ*). *Fidenidæ*.
Four genera, *Sepiola*, *Sepioloidea*, *Fidenas*, *Cranchia*.

25. *Sepiola*, Leach, 1817 Body short; mantle, with broad neck band, and two ventral ridges; fins lateral, small, circular, wing-like; arms slender, with two or more rows of suckers; tentacles wholly retractile, with eight rows of suckers; pen half the length of body, narrow.
26. *Sepioloidea*, D'Orbigny, 1839 Body short; mantle ciliated at its upper edge; fins lateral, long, circular, wing-like; arms almost all united by a membrane; pen contracted in the middle.
27. *Fidenas*, Gray, 1849 Body oblong; mantle with broad neck band and two ventral ridges; fins lateral, wing-like, small; arms partly united by a membrane, with suckers in two rows on stalks; pen narrow with a central and two side ridges.
28. *Cranchia*, Leach, 1817..... Body circular; mantle attached to body by a neck band, and two ventral septa; head small; fins very small, terminal, round; arms short, with two rows of suckers; tentacles with four rows of suckers; funnel valved; pen contracted in middle, and pointed at each end.

2. *The Calcareous Shelled Cuttles, with ten arms, SEPIADÆ* (Owen, 1838).

IX.—SEPIADÆ. Animal having a calcareous internal shell. One genus, *Sepia*.

29. *Sepia*, Linné, 1801 Body oblong; mantle attached to body by a neck band; fins lateral, long; arms, with the exception of the fourth pair united at their base by a membrane; the fourth pair with a terminal expansion; four rows of suckers with horny margins; tentacles long, completely retractile, suckers unequal, and in many rows; pen (*sepiostaire, bone*) long, oval, with a pointed termination.

3. *The Chambered Shelled Cuttles, with ten arms, SPIRULIDÆ* (Owen, 1838).

X.—SPIRULIDÆ. Animal having a *nacreous* involute shell, the turns separate, many chambered, with a ventral siphuncle, the shell partly external. One genus, *Spirula*.

30. *Spirula*, Lamarck, 1801 Body oblong; mantle supported by a dorsal and two ventral ridges fitting in corresponding grooves in the body. Fins terminal, small arms with six rows of suckers. Tentacles elongated. Shell spiral, in the same plane, many chambered, the last occupied by a part of the body of the animal.

SECOND ORDER.—TETRABRANCHIATA (Owen, 1832), CONTAINING ONLY ONE
RECENT GENUS, NAUTILUS.

31. Nautilus, Breynius, 1732 Body round, furnished with a considerable number of arms, one pair of which are expanded and form the hood to close the aperture of the shell; arms retractile into sheaths, without suckers; fins absent; eyes large, on stalks. Shell involute, with the later whorls partially enveloping the earlier, many chambered, each chamber perforated by a central siphuncle, the exterior chamber containing the body of the animal; aperture of last chamber regular, septa of chambers without irregular folds.

APPENDIX II.

SCHEDULE OF THE FOSSIL CEPHALOPODA.

DESCRIPTION OF THE CLASS.

ANIMAL generally unknown, allied either to the Argonauta, to the families of the Decapoda, or to the Nautili. SHELL, either internal or external; sometimes lance-shaped, generally chambered, and in form founded upon the motion of a point revolving and advancing in space about a central axis, the axis itself being straight or curved, or a combination of straight lines and curves, in the same plane, or not in the same plane. Exterior chamber generally large, with the outer edge open or contracted. CHAMBERS divided by partitions (*Septa*), with edges (*Sutures*) plain, slightly or intricately undulating, with elevations (*saddles*), and depressions (*lobes*); Chambers pierced by a small opening (leading into the *Siphuncle*), variable in position.

The fossil Cephalopoda are divided into families and genera, depending upon the form of the shell, the undulations of the partitions (*Septa*), the position of the small opening (*Siphuncle*), and the plan of the external chamber, etc., and may be thus tabulated:—

Dibranchiata	{	Octopoda... I. Argonautidæ	1. Argonauta
		II. Onychoteuthidæ ...	{ 2. Enoploteuthis 3. Plesiotheuthis 4. Ommastrephes
	{	III. Gonatidæ	5. Loligo
		IV. Beloteuthidæ	{ 6. Teudopsis 7. Phylloteuthis 8. Beloteuthis 9. Geoteuthis 10. Leptoteuthis
	{	Decapoda... V. Sepiadæ	11. Sepia
		VI. Belemnositæ	{ 12. Belemnosis 13. Beloptera 14. Helicurus 15. Spirulirostra
	{	VII. Belemnitidæ	{ 16. Belemnites 17. Belemnitella 18. Belemnoteuthis 19. Conoteuthis 20. Xiphotheuthis
Tetrabranchiata.....	{		21. Nautilus
			22. Discoceras
			23. Ophidioceras
			24. Gyroceras
			25. Cyrtoceras
			26. Cyrtocarina
			27. Oncoceras
			28. Streptoceras
			29. Piloceras
			30. Lituities
			30a. Lituunculus
			31. Orthoceras
			32. Tretoceras
			33. Huronia
	{	VIII. Nautilitidæ	34. Actinoceras
			35. Ormoceras
			36. Aulacoceras
			37. Endoceras
			38. Cameroceras
			39. Trochoceras
			40. Hercoceras
			41. Gomphoceras
			42. Phragmoceras
			43. Ascoceras
	{		44. Glossoceras
			45. Aphragmites
			46. Aturia
			47. Nothoceras
			48. Bathmoceras
			49. Gonioceras
	{	IX. Goniatidæ	50. Goniatites
			51. Clymenia
			52. Bactrites

Tetrabranchiata (<i>continued</i>).....	X. Clydonitidæ	53. Clydonites
		54. Choristoceras
		55. Rhabdoceras
		56. Cochloceras
	XI. Ceratitidæ	57. Ceratites
		58. Baculina
	XII. Ammonitidæ.....	59. Ammonites
		60. Crioceras
		61. Toxoceras
		62. Scaphites
		63. Ancyloceras
		64. Ptychoceras
		65. Hamites
		66. Hamulina
		67. Baculites
		68. Turritiles
		69. Helicoceras
		70. Heteroceras
		71. Anisoceras.

ANALYSIS OF THE FAMILIES AND GENERA OF THE FOSSIL CEPHALOPODA.

FIRST ORDER.—DIBRANCHIATA, CONTAINING SECTION I. OCTOPODA, AND SECTION II. DECAPODA.

Section I.—(OCTOPODA) of First Order (Dibranchiata).

I.—Shell involute, the turns in the same plane, thin, single chambered. Family, ARGONAUTIDÆ (Reeve, 1841). One fossil genus, Argonauta.

1. ARGONAUTA, Linné, 1758 Tertiary.

Section II.—(DECAPODA) of First Order (Dibranchiata).

II.—Shell lance-shape, slender, with central ridge, generally terminating in a slight expansion of no great length without air chambers. Family, ONYCHOTEUTHIDÆ (Gray, 1847). Three fossil genera, Enoplateuthis, Plesiot euthis, and Ommastrephes.

2. ENOPLATEUTHIS, D'Orbigny, 1839... Sides sinuous, with lateral expansions; central ridge keeled; Oolitic.
3. PLESIOTEUTHIS, Wagner, 1860 Sides sinuous, with central and two side ridges; projection arrow-shaped; arms with hooks; Liassic.
4. OMMASTREPHEs, D'Orbigny, 1845 ... Sides generally straight, contracted towards base, point expanded, central and side ridges; Oolitic.

III.—Shell lance-shape, slender, with central keeled ridge, and side expansions of some length. Family, GONATIDÆ. One fossil genus, Loligo.

5. LOLIGO, Lamarck, 1799 Liassic.

IV.—Shell lance-shape, subovate, with central ridge, and side expansions of some length. Family, BELOTEUTHIDÆ. Five fossil genera, Teudopsis, Phylloteuthis, Beloteuthis, Geoteuthis, and Leptoteuthis.

6. TEUDOPSIS, Deslongchamps, 1835 ... Narrow at top, enlarged below, with a concavity at base, and narrow central rib; Liassic into Oolite.
7. PHYLLOTEUTHIS, Meek and Hayden, 1858. Narrow at top, enlarged below, with slight concavity at base, where the lateral margins are obtusely angular; Cretaceous.
8. BELOTEUTHIS, Munster, 1843 Pointed at top and bottom, lateral expansions forming a sudden angle on the sides towards the lower half of total length; Liassic.
9. GEOTEUTHIS, Munster, 1843 Wide at top, pointed at base, side expansions forming a sudden angle on the sides towards the upper half of total length; Liassic.
 = Belemnosepia, Agassiz, 1835.
 = Loligosepia, Quenstedt, 1843.
 = Coccoteuthis (pars), Owen, 1855.
10. LEPTOTEUTHIS, Meyer, 1824 Wide and rounded at top, pointed at base, lateral expansions gradually angular, ribs slight and diverging; Oolitic.

V.—Shell ovate, thick, with thin lateral projections, inclined to the sides, terminating in a projecting point imperfectly chambered. Family, SEPIADÆ (Owen, 1838). One fossil genus, Sepia.

11. SEPIA, Liuné, 1801..... Oolitic and Tertiary.
 = Belosepia, Voltz, 1830
 = Sepiolithes, Munster, 1843
 = Trachyteuthis, Meyer, 1846.
 = Coccoteuthis, Owen, 1855.
 = Palæoteuthis, Roemer, 1856.

VI.—Shell conical, slightly bent, having at its upper part a cavity containing chambers with a siphuncle. Family, BELEMNOSIDÆ. Four fossil genera, Belemnosis, Beloptera, Helicerus, and Spirulirostra.

12. BELEMNOSIS, Edwards, 1849 Shell conical, and suddenly bent at a short distance from the base, no side expansions; Tertiary.
13. BELOPTERA, Deshayes, 1830 Shell conical, and slightly bent, side expansions at the angle; Tertiary.
14. HELICERUS, Dana, 1849..... Shell conical, the chambers at the upper part, slender and terminating in a spiral arrangement; Liassic?
15. SPIRULIROSTRA, D'Orbigny, 1842... Shell conical, the chambers at the upper part, of some size and terminating in a spiral arrangement, the portion covering the commencement of the spiral projected forwards, the extremity pointed; Tertiary.

VII.—Shell straight, with a series of conical chambers at its upper portion. Family, BELEMNITIDÆ (Owen, 1838). Five fossil genera, Belemnites, Belemnitella, Belemnoteuthis, Conoteuthis, and Xiphoteuthis.

16. **BELEMNITES**, Lister, 1678 Shell (guard) straight, generally long, somewhat cylindrical, conical below, with a hollow cone (alveolus) in the upper part, containing a chambered cone (phragmocone), which has a marginal canal (siphuncle); the thin, shelly covering (conotheca) investing the chambers, prolonged on one side into a broad lobe (pro-ostracum, pen); animal not clearly known, double rows of hooks on the arms; from Liassic into Cretaceous formations.
 = *Belemnitis lapis*, Agricola, 1546.
 = *Belemnites*, Gesner, 1565.
 = *Acamas*, Montfort, 1808.
 = *Hibolithes*, Montfort, 1808.
 = *Thalamus* (= alveolus, &c.), 1808.
 = *Actinocamax*, Miller, 1823.
 = *Pseudobelus*, Blainville, 1827.
 = *Belemnosepia*, Buckland, 1836.
 = *Belopeltis*, Voltz, 1840 (a pro-ostracum).
 = *Notosiphites*, Duval-Jouve, 1841.
 = *Gasterosiphites*, " "
17. **BELEMNITELLA**, D'Orbigny, 1840 ... Shell (guard) in its highest part, marked by a short longitudinal slit; Cretaceous.
18. **BELEMNOTEUTHIS**, Pearce, 1842 ... Shell consisting of a chambered cone, having at its upper part a horny pen with thin side bands, and at its lowest part a thin fibrous guard, with two diverging ridges; animal with arms and horny hooks, fins large; Oolitic.
 = *Kelæno*, Munster, 1836.
 = *Acanthoteuthis*, Munster, 1839.
 = *Plesioteuthis*, Wagner, 1860.
19. **CONOTEUTHIS**, D'Orbigny, 1840 ... Chambered cone slightly curved, pen elongated and very narrow; Cretaceous.
20. **XIPHOTEUTHIS**, Huxley, 1864 Shell cylindrical; chambered cone long and narrow; pen very long and slender, section an ellipse; Liassic.
 = *Orthocera* (pars), De la Beche, 1829.

SECOND ORDER.—TETRABRANCHIATA.

VIII.—Shell many chambered; the last (exterior) chamber large, siphuncle generally subcentral; the edges of the partitions (septa) which separate the chambers either *without folds*, or slightly undulating. Family, **NAUTILIDÆ**. Thirty fossil genera: *Nautilus*, *Discoceras*, *Ophidioceras*, *Gyroceras*, *Cyrtoceras*, *Cyrtocarina*, *Oncoceras*, *Streptoceras*, *Piloceras*, *Lituites*, *Lituunculus*, *Orthoceras*, *Tretoceras*, *Huronia*, *Actinoceras*, *Ormoceras*, *Aulacoceras*, *Endoceras*, *Cameroceras*, *Trochoceras*, *Hercoceras*, *Gomphoceras*, *Phragmoceras*, *Ascoceras*, *Glossoceras*, *Aphragmites*, *Aturia*, *Nothoceras*, *Bathmoceras*, and *Gónioceras*.

DIVISION A.—Edges of septa without fold.

1. Shell spiral, in the same plane.

21. **NAUTILUS**, Breynius, 1732 Turns (*whorls*) of the shell, in contact, partially overlapping; siphuncle almost central; aperture of exterior chamber open, without folds; Silurian into Tertiary, still living.
 = *Nautilus*, Belon, 1553.
 = *Planorbites*, Lamarck, 1799.
 = *Angulithes*, Montfort, 1808.
 = *Oceanus*, " "
 = *Ammonites* (*pars*), Montfort, 1808.
 = *Bisiphites* (*pars*), " "
 = *Conchyliolithus*, Martin, 1809.
 = *Ammonellipsites*, Parkinson, 1811.
 = *Ellipsolithes* (*pars*), Sowerby, 1812.

- = Rhabdites, De Haan, 1825.
 = Omphalia, " "
 = Globites, " "
 = Aganides (*pars*), D'Orbigny, 1826.
 = Aganites (*pars*), Quenstedt, 1834.
 = Aturia (*pars*), Brown, 1835.
 = Hamites (*pars*), Fischer, 1837.
 = Trocholites (*pars*), Conrad, 1838.
 = Simplegas (*pars*), Sowerby, 1842.
 = Discites (*pars*), McCoy, 1844.
 = Discus (*pars*), King, "
 = Cryptoceras (*pars*), D'Orbigny, 1850.
 = Trematodiscus (*pars*), Meek, 1861.
 RHYNCHOLITHES, Faure-Biguet, 1819. Comprising the beaks of the Nautilus animal.
 = Conchorynchus, De Blainville, 1827.
 = Rhynchoteuthis, D'Orbigny, 1847.
22. DISCOCERAS, Barrande, 1867 Turns of the shell touching, siphuncle variable; aperture of exterior chamber open, its edge not contracted; Silurian.
23. OPHIDIOCERAS, Barrande, 1867 Turns of the shell touching; siphuncle variable; aperture of exterior chamber contracted; Silurian.
24. GYROCERAS, De Koninck, 1844 Turns of the shell not in contact; siphuncle marginal, on external (convex) side; last chamber somewhat small, edge without fold; from Silurian into Carboniferous.
 = Gyroceratites, H. von Meyer, 1829.
 = Hortolus, Steininger, 1831.
 = Spirula, Goldfuss, 1832.
 = Lituites, Quenstedt, 1834.
 = Cyrtocera (*pars*), Münster, 1839.
 = Cyrtoceras (*pars*), Phillips, 1841.
 = Cyrtoceratites (*pars*), D'Archiac, 1842.
2. Shell an arc of a Spiral, in the same plane.
25. CYRTOCERAS, Goldfuss, 1832 Shell slightly curved, never forming a complete revolution; siphuncle variable in position, generally on convex side; exterior chamber open, its edge not contracted; from Silurian into Devonian.
 = Orthoceratites, Lamarck, 1799.
 = Orthocera (*pars*), Sowerby, 1812.
 = Campulites, Deshayes, 1832.
 = Lituites (*pars*), Quenstedt, 1836.
 = Cyrtoceratites, D'Archiac, 1842.
 = Trigonoceras, M' Coy, 1844.
 = Campyloceras, " "
 = Aploceras, D'Orbigny, 1850.
26. CYRTOCERINA, Billings, 1865 Shell like Cyrtoceras, but shorter and thicker; Silurian.
27. ONCOCERAS, Hall, 1847 Shell slightly curved, pear-shaped; siphuncle lateral, edge of exterior chamber contracted in the middle; Silurian.
28. STREPTOCERAS, Billings, 1866 Shell slightly curved, pear-shaped, edge of exterior chamber contracted to form three lobes; Silurian.
29. PILOCERAS, Salter (read 1858), 1859 Same as Cyrtoceras, but the septa forming a series of conical partitions, pointing towards the smaller (earliest) part of the shell; Silurian.

3. Shell a combination of curved and straight lines in the same plane.

30. *LITUITES*, Breynius, 1732 Turns of the shell at first generally in contact, afterwards tangentially divergent; siphuncle variable; edge of exterior chamber contracted; Silurian.
 = *Hortolus*, Montfort, 1808.
 = *Spirulites*, Parkinson, 1811.
 = *Clymenia (pars)*, Eichwald, 1842.
 = *Ancistroceras (pars)*, Boll, 1857.
- 30a. *LITUUNCULUS*, Barrande, 1867. Same as *Lituities*, but with the edge of the exterior chamber contracted, the form ideal, not yet discovered in rocks; Silurian?

4. Shell straight.

31. *ORTHOCERAS*, Breynius, 1732 Siphuncle small, almost central, bead-like; aperture of exterior chamber open, without folds; from Silurian into Trias.
 = *Molossus*, Montfort, 1808.
 = *Echidnis* " "
 = *Achelois* " "
 = *Hyolithes*, Eichwald, 1842.
 = *Koleoceras*, Portlock, 1843.
 = *Cycloceras*, McCoy, 1844.
32. *TRETOCERAS*, Salter, read 1856, 1858 Siphuncle small, almost central, bead-like; the chambers surrounding the siphuncle pieced by a longitudinal tube; Silurian.
33. *HURONIA*, Stokes, 1840 Siphuncle large, central, the upper part of each division expanded and connected with a small central tube by radiating plates; Silurian.
34. *ACTINOCERAS*, Stokes, 1840 Siphuncle large, central, the middle part of each division expanded and connected with a small central tube by radiating plates; Silurian into Carboniferous.
35. *ORMOCERAS*, Stokes, 1840 Siphuncle large, almost central, bead-like, the middle of each division contracted; Silurian into Devonian.
36. *AULOCERAS*, Hauer, 1860 Siphuncle small, lateral, plain; shell externally corrugated thickening towards the base. Trias.
37. *ENDOCERAS*, Hall, 1847 Siphuncle large, lateral with cone-like partitions, inserted in each other, their points being directed towards the small or earliest portion of the shell; Silurian.
38. *CAMEROCERAS*, Conrad, 1847 Siphuncle sometimes large, lateral, not complex; Silurian into Trias.
 = *Melia*, Fischer, 1829.
 = *Thoracoceras*, Fischer, 1844.

5. Shell spiral, not in the same plane.

39. *TROCHOCERAS*, Barrande, 1847 Turns of the shell at first in contact, not overlapping, afterwards generally spirally divergent, occasionally tangentially divergent; siphuncle mostly near the margin on the outer (convex) side, edge of exterior chamber without fold; Silurian.
40. *HERCOCERAS*, Barrande, 1865 Turns of the shell at first in contact, slightly overlapping, afterwards spirally divergent; siphuncle marginal on outer side, edge of exterior chamber contracted and compressed transversely; Silurian.

6. Shell neither spiral nor linear.

41. GOMPHOCERAS, Sowerby, 1839 Shell straight, pear-shaped; aperture of exterior chamber contracted, small and lobed, the exterior chamber somewhat globular; position of siphuncle variable; from Silurian into Carboniferous.
 = Orthoceras (*pars*), Sowerby, 1812.
 = Conilites, Pusch, 1837.
 = Nelimenia, Castelnau, 1843.
 = Bolboceras, Fischer, 1844.
 = Apioceras, " "
 = Poterioceras, McCoy, "
 = Lituities (*pars*), Quenstedt, 1846.
 = Syncoceras (*pars*), Pictet, 1854.
42. PHRAGMOCERAS, Broderip, 1839 ... Shell slightly curved, pear-shaped; aperture of exterior chamber contracted, small and lobed; siphuncle generally on the internal (concave) side; from Silurian into Devonian.
 = Campulites (*pars*) Deshayes, 1830.
 = Orthoceratites, Steininger, 1831.
43. ASCOCERAS, Barrande, 1847 Shell slightly curved, flask-shaped, lower portion more globular than the upper, partitions of the chambers few and running parallel to the long axis of the shell, leaving a space the whole length of the shell for the body of the creature, aperture of exterior chamber not lobed; Silurian.
 = Cryptoceras, Barrande, 1846.
44. GLOSSOCERAS, Barrande, 1865 Shell same as in Ascoceras, but with the aperture of the exterior chamber lobed; Silurian.
45. APHRAGMITES, Barrande, 1865 Shell same in general form as Ascoceras, but without several internal partitions, aperture not lobed; Silurian.

DIVISION B.—Edges of septa with a single marked fold.

1. Shell spiral in the same plane.

46. ATURIA, Brown, 1837..... The turns of the shell in contact overlapping; siphuncle almost marginal, on concave (inner) edge, and formed of a series of inserted cone shaped partitions; edges of the partitions separating the chamber with a strong lateral lobe. Cretaceous into Tertiary.
47. NOTHOCERAS, Barrande, 1856 Turns of the shell slightly overlapping, siphuncle marginal, on convex (outer) side, and furnished with internal radiating plates; septa with a slight lobe on the back of the shell, corresponding in direction to that of the Ammonites; aperture not lobed; Silurian.

2. Shell straight.

48. BATHMOCERAS, Barrande, 1856 Siphuncle marginal, containing a series of inserted cone-like partitions, whose points are directed towards the final chamber, being the reverse of that observed in Endoceras. Septa incomplete towards the final chamber, and with a slight lobe, planned as in Nothoceras, aperture not lobed; Silurian.

49. GONIOCERAS, Hall, 1847 Siphuncle marginal. Septa waved, shell compressed into an elliptic form; Silurian.

IX.—Shell many chambered ; the last (exterior) chamber large ; siphuncle marginal ; the edges of the partitions (septa) which separate the chambers, angulated or waved, but not dentated or foliated. Family, GONIATIDÆ (Barrande, 1867). Three genera : Goniatites, Clymenia, and Bactrites.

1. Shell spiral in the same plane.

50. GONIATITES, De Haan, 1825 The turns of the shell in contact, overlapping ; siphuncle near the outer (convex) side ; edges of the partitions separating the chambers much waved, but not having at their base small, convex, toothlike projections ; from Silurian into Trias.
- Nautilus, Lamarck, 1799.
- Orbulites, „ 1801.
- Aganides, Montfort, 1808.
- Nautellipsites, Parkinson, 1811.
- Ellipsolithes (*pars*), Sowerby, 1812.
51. CLYMENIA, Munster, 1832. The turns of the shell in contact, overlapping ; siphuncle near the inner (concave) side ; edges of partitions waved with slight angular depressions. (This genus has affinities with *Aturia*, but the turns of the shell are more overlapping in the latter, and the siphuncle is larger). Devonian into Carboniferous.
- = Endosiphonites, Ansted, 1840.
- = Subclymenia, D'Orbigny, 1850.

2. Shell straight.

52. BACTRITES, Sandberger, 1841. Siphuncle marginal ; septa gently waved, a single angular depression (lobe) ; external chamber not known ; from Silurian into Devonian.
- = Stenoceras, D'Orbigny, 1850.
- = Trematoceras, Eichwald, 1851.

X.—Shell many chambered ; the last (exterior) chamber large ; siphuncle marginal ; the edges of the partitions (septa), which separate the chambers, many-waved, with single circular or subcircular depressions at their base. Family, CLYDONITIDÆ. Four genera : Clydonites, Choristoceras, Rhabdoceras, and Cochloceras.

1. Shell spiral, the turns touching, in the same plane.

53. CLYDONITES, Hauer, 1860 Triassic and Cretaceous.

2. Shell spiral, the turns not touching, in the same plane.

54. CHORISTOCERAS, Hauer, 1865 Triassic.

3. Shell straight.

55. RHABDOCERAS, Hauer, 1860 Triassic.

4. Shell spiral, the turns touching, not in the same plane.

56. COCHLOCERAS, Hauer, 1860 Triassic.

XI.—Shell many chambered ; the last (exterior) chamber large, siphuncle marginal (dorsal) ; the edges of the partitions (septa), which separate the chambers, waved, with many small circular elevations (crenulations) at the base of each wave. CERATITIDÆ. Two genera : Ceratites and Baculina.

1. Shell spiral, the turns touching, in the same plane.

57. CERATITES, De Haan, 1825 From Triassic into Cretaceous.

2. Shell straight.

58. BACULINA, D'Orbigny, 1850 Cretaceous.

XII.—Shell many chambered; the last (exterior) chamber large, siphuncle marginal (dorsal); the edges of the partitions (septa), which separate the chambers, foliaceous. AMMONITIDÆ (Owen, 1838). Thirteen genera: Ammonites, Crioceras, Toxoceras, Scaphites, Ancyloceras, Ptychoceras, Hamites, Hamulina, Baculites, Turritiles, Helicoceras, Heteroceras, and Anisoceras.

1. Shell spiral, in the same plane.

59. AMMONITES, Bruguière, 1789 Turns of the shell in contact, overlapping; siphuncle on the exterior side; Triassic into Cretaceous.
 = Ammonis cornu, Auctorum.
 = Planorbites, Lamarck, 1799.
 = Planulites, Lamarck, 1801.
 = Amaltheus, Montfort, 1808.
 = Orbulites
 = Globites, De Haan, 1825.
 = Planites,
 APTYCHUS, H. von Meyer, 1831 ... Opercula, or doors, closing the external opening of the Ammonite shell.
 = Trigonellites, Parkinson, 1811.
 = Tellinites, Schlotheim, 1813.
 = Münsteria, Deslongchamps, 1835.
 = Ichthyosiagones, Bourdet, 1822.
 Peltarion, Deslongchamps, 1859 ... Circular, or somewhat oval calcareous plates, with an undulating margin, supposed to be connected with the mandibles of the Ammonite animal; Lias into Oolite.)

2. Shell spiral, turns of the shell not in contact, in the same plane.

60. CRIOCERAS Cretaceous.
 = Crioceratites, Leveillé, 1837.
 = Tropæum, Sowerby, 1840.

3. Shell an arc of a spiral, in the same plane.

61. TOXOCERAS, D'Orbigny, 1840 Cretaceous.
 = Toxocerus, King, 1844.

4. Shell changing from a spiral, in the same plane.

62. SCAPHITES, Parkinson, 1811 Turns of the shell at first spiral, in contact, and overlapping, afterwards tangentially divergent; finally recurved and not in contact; Cretaceous.
 63. ANCYLOCERAS, D'Orbigny, 1840 ... Turns of the shell at first spiral, *not* in contact, afterwards tangentially divergent; finally recurved, and not in contact; from Oolitic into Cretaceous formations.

5. Shell forming straight and curved lines, in the same plane.

64. PTYCHOCERAS, D'Orbigny, 1840 ... The shell at first straight, afterwards curved, and next straight, the turns in contact; Cretaceous.
 = Ptychocerus, King, 1844.

65. HAMITES, Parkinson, 1811..... The shell at first straight, afterwards curved, and next twice repeating the process; the arrangement forming a species of compressed spiral; the turns *not* in contact; Cretaceous.
 =Baculita, Fleming, 1828.
 =Toxerites, Rafinesque, 1818.
66. HAMULINA, D'Orbigny, 1850 The shell at first straight, afterwards curved, next straight, the turns *not* in contact; Cretaceous.

6. Shell forming a straight line.

67. BACULITES, Lamarck, 1801 The shell slightly conical; Cretaceous.
 =Homaloceratites, Hüpsch, 1781.
 =Tiranites, Montfort, 1808.
 =Baculita, Fleming, 1828.

7. Shell spiral, not in the same plane.

68. TURRILITES, Lamarck, 1801 Turns of the shell spiral, in contact;
 =Turriles, De Haan, 1825. Oolitic into Cretaceous.
 =Turrilithes „ „
69. HELIOCERAS, D'Orbigny, 1840 ... Turns of the shell spiral, *not* in contact;
 =Heliocerus, King, 1844. Oolitic into Cretaceous.

8. Shell forming straight and curved lines, not in the same plane.

70. HETERO CERAS, D'Orbigny, 1850 ... Turns of the shell at first spiral and in contact, not in the same plane, afterwards tangentially divergent, finally recurved and *not* in contact, and produced at a different angle to that of the spiral; Cretaceous.
71. ANISOCERAS, Pictet, 1854 Turns of the shell at first spiral, not in the same plane, next tangentially divergent, and finally recurved, none of the turns in contact; Oolitic into Cretaceous.

APPENDIX III.

RANGE OF THE GENERA OF THE FOSSIL CEPHALOPODA
IN GEOLOGICAL TIME.*

	Tertiary.	Cretaceous.	Jurassic †	Triassic.	Permian.	Carboniferous.	Devonian.	Silurian.
1. Argonauta	*
2. Enoploteuthis	*
3. Plesioteuthis	*
4. Ommastrephes	*
5. Loligo	*
6. Teudopsis	*
7. Phylloteuthis	*
8. Belemnites	*
9. Geoteuthis	*
10. Leptoteuthis	*
11. Sepia	*	...	*
12. Belemnosis
13. Belemnites	*
14. Beloptera	*
15. Heliceras	* ^o	...	...	...	...	...
16. Spirulirostra	*
17. Belemnites	*	*
18. Belemnitella	*
19. Belemniteuthis	*
20. Conoteuthis	*
21. Xiphoteuthis	*
22. Nautilus	*	*	*	*	*	*	*	*
23. Discoceras	*
24. Ophidioceras	*
25. Gyroceras	*	*	*

* The stars opposite a genus in one or more of the columns, show that the genus existed in the geological period referred to in the column or columns.

† The Jurassic formation includes the Oolite and the Lias.

	Tertiary.	Cretaceous.	Jurassic.	Triassic.	Permian.	Carboniferous.	Devonian.	Silurian.
25. Cyrtoceras	*	*
26. Cyrtocerina	*
27. Oncoceras	*
28. Streptoceras	*
29. Piloceras	*
30. Lituities	*
31. Orthoceras	*	*	*	*	*
32. Tretoceras	*
33. Huronia	*
34. Actinoceras	*	*	*
35. Ormoceras	*	..
36. Aulacoceras	*
37. Endoceras	*
38. Cameroceras	*	*	*	*	*
39. Trochoceras	*
40. Hercoceras	*
41. Gomphoceras	*	*	*
42. Phragmoceras	*	*
43. Ascoceras	*
44. Glossoceras	*
45. Aphragmites	*
46. Aturia	*	*
47. Nothoceras	*
48. Bathmoceras	*
49. Gonioceras	*
50. Goniatites	*	*	*	*	*
51. Clymenia	*	*	..
52. Bactrites	*	*
53. Clydonites	*	..	*
54. Choristoceras	*
55. Rhabdoceras	*
56. Cochloceras	*
57. Ceratites	*	*	*
58. Baculina	*
59. Ammonites	*	*	*
60. Crioceras	*
61. Toxoceras	*
62. Scaphites	*
63. Ancyloceras	*	*
64. Ptychoceras	*
65. Hamites	*
66. Hamulina	*
67. Baculites	*
68. Turrilites	*	*
69. Helicoceras	*	*
70. Heteroceras	*
71. Anisoceras	*	*

RANGE OF THE FAMILIES OF THE FOSSIL CEPHALOPODA
IN GEOLOGICAL TIME.

	Tertiary.	Cretaceous.	Jurassic.	Triassic.	Permian.	Carboniferous.	Devonian.	Silurian.
I. Argonautidæ	*
II. Onychoteuthidæ	*
III. Gonatidæ	*
IV. Beloteuthidæ	*	*
V. Sepiadæ	*	...	*
VI. Belemnositæ	*	...	*
VII. Belemnitidæ	*	*
VIII. Nautilitidæ	*	*	*	*	*	*	*	*
IX. Goniatidæ	*	*	*	*	*
X. Clydonitidæ	*	...	*
XI. Ceratitidæ	*	*	*
XII. Ammonitidæ	*	*	*



